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THE ROMANTIC PHASES OF ENGINEERING.

This is a commonplace world we live in—at least, so it seems to those of us who are doing every day what comes to hand, and who seldom stop to take a look around and see what others are doing and how fares the world. Familiarity, it is said, breeds contempt, and all things seem common if seen often. Some of us wish, with McAndrews, for some one to sing the song of steam, the song of modern engineering; to tell us of the picturesque sides of our daily life; to throw around familiar objects a veil, which, by rendering them less distinct, brings out the romantic sides. Yet there are many ordinary things which are as wonderful as the old fairy tales. And was Aladdin's lamp so very wonderful? To-day we touch a button when a messenger is needed; we press another, and the room is flooded with light. It is not recorded that Aladdin's old brass implement was of any value for illuminating a dark room. Our slaves of the lamp do not terrify us by their horrid appearance: they are placed afar off in a home of their own and are always ready to furnish us with light and heat at any time of the day or night. Is not that simpler and more direct than to have to carry an ugly piece of brass about with us, which, when rubbed, did not give what was wanted, but merely brought the servant?

And was the magic mirror so much superior to the telephone? Who would not prefer to talk with his friends to merely seeing them dimly through a clouded mirror? Truly the telephone is one of the most romantic devices that has ever rewarded man's endeavors. And yet the magic mirror, while it seems improbable to-day, is not impossible, for some little discovery may lead to it; but even then it would only supplement the telephone.

And in what way was the fairy boat or coach superior to the electric launch or automobile? True, the rider did not know how or why it moved! But this same advantage holds for many who to-day use these very equipages. And one can easily believe that we are not far from the true flying machine, although the latter, if it ever be brought to a state of practical utility, will most probably draw its power from odorous gasolene or cursed alcohol, two of the most despised fluids known to-day.

The mistake which has been made by the engineer is due to his wish to have all share the benefits of his magic hand. Had he been content to build a single electric car for his own use, and allowed no one else to ride, the novelty would not have worn off. For does the substitution of the unseen motor for the laboring and dust-raising horses render the electric motor any less romantic than the stage coach of old?

This same spirit has brought the engineer into ill-favor with

others who think that Nature's crude wastes are of greater value to humanity than the work which might be done instead. It is better, they say, to leave the water powers alone, although they might be used to heat and clothe many who would otherwise lack these comforts. But is it not the engineer's duty to take advantage of every one of Nature's gifts for the benefit of his fellow creatures? Has not every stream a duty to perform, just as well as the land which borders it? Should not the spirit of the Chattahoochee be that of all streams?

> But, oh, not the hills of Habersham,
> And, oh, not the valleys of Hall
> Avail: I am fain for to water the plain.
> Downward the voices of duty call—
> Downward, to toil and be mixed with the main,
> For the dry fields burn, and the mills are to turn,
> And a myriad flowers mortally yearn;
> And the lordly main from beyond the plain
> Calls o'er the hills of Habersham,
> Calls through the valleys of Hall!

THE REASONS FOR THE GREAT ELECTRICAL DEVELOPMENT.

In looking back over the past twenty-five years to take stock of what has been accomplished in the application of electrical methods, one of the most astonishing features, which time and again impresses itself upon the reviewer, is the remarkable rate at which this development has gone on. This is true of nearly all of those which may be called the modern applications, and which form a group that practically includes all, with the exception of the telegraph and the electroplating industries. And not only has this growth taken place at a marvelous rate, but the rate itself has been increasing, until one wonders what the end will be.

The question very naturally arises, then, what have been the reasons for this? Why is it that the introduction of the electric motor has gone on at a rate far greater than that accompanying the introduction of the steam engine? The latter marked the beginning of a great industrial period, a period during which hand labor was largely superseded by that of machines. The steam engine, it must be remembered, gave us an entirely new source of power. Previously the only power worth considering was that of the waterfalls, and these, when they existed, were often in inaccessible or inconvenient places. The factory had to be placed where the power existed; there was no alternative. The steam engine, however, changed this, and it became possible to place the factory or mill where most convenient and to bring power to it in the form of coal. This advance has been a controlling influence in industrial development; yet the introduction of the steam engine, even after it had been reduced to a practical form, was slow compared with the rate at which the electrical systems have grown.

Why should this be? It is, of course, true that mechanical arts were well advanced when the electric motor was invented, and when it was found that the motor was better for certain purposes than the steam engine the former naturally took the latter's place. But this change constitutes only a small part of the great electrical development. The motor is used as well for purposes in which the steam engine never succeeded, and other entirely new arts have come into existence, been perfected and spread at the same astonishing rate.

There is one fundamental reason for this: it is the ease with which electric power is distributed. When one uses a steam engine it is generally necessary to develop the power at the point where it is to be used or at least within a short distance. In general, every user of power must make his own power. With electric power, on the other hand, distribution is easy. It can be produced at any convenient place, easily carried where needed, and easily subdivided. A large power station may be placed where coal and water are accessible, and power from this be used throughout a large area for driving mills, running elevators, operating railroads, turning the little office contrivances and fans, and lighting the streets and homes of the cities. And if a water power exist, it matters not very much where it be, provided only it is within a hundred miles of the place where power is wanted. In other words, the electrical system is merely a means of distributing power; it is not, as was the steam engine, a new source of power. And, moreover, the power generated in the largest station is suitable for performing the smallest offices in the remotest corner of the district.

And the same is true of the other industries, such, for example, as the telephone. It is the ease with which electrical disturbances set up in a wire at one point—in other words, electrical energy—may be transmitted to another point and utilized which made the telephone possible. It is the ease with which any one with a telephone can almost instantly reach any other telephone user that has led to the marvelous spread of the telephone. Telephone systems are, in fact, special cases of electrical generation and distribution. The electric railway is another peculiar case. Here the requirement is that the power be delivered to a moving vehicle. The electrical system is the only one which has been devised which is flexible enough for use under all conditions.

There is, it seems, but one exception to this general principle, and that is the electrochemical industries; but even here the ease with which the energy of waterfalls may be delivered at the chemical works has been largely accountable for the great growth of these industries, though in this case electrical energy is not used as a motive power, but in place of other processes for producing chemical reactions.

The ease of transmission and distribution—what is frequently called the flexibility of the electrical system—is therefore the reason for the growth. When, in addition, it is remembered that the electrical systems which have been devised are safe, noiseless and clean, and that therefore they are suitable for all kinds of work and for all classes, one understands why they have carried all before them; why they are the best for the palace and the factory, for work on the street and on shipboard, for transporting heavy freight and conversations.

A phase of this development which is frequently overlooked is the springing up of a commerce in power. Heretofore men dealt in materials, and when they needed power they made it.

Now one buys his power from companies who have made a specialty of its manufacture, and who deliver it when and where it is wanted, and in the kind and quantity desired. This is an entirely new branch of industry, and is one which is becoming daily more important.

THE EFFICIENCY OF TURBO-ALTERNATORS.

The advent of the steam turbine into the field of motive-power engineering has resulted in many changes in power plant design, but perhaps the most significant departure from previous practice is in connection with the design of electric generators for direct connection to turbines. The increase in speed has been so great that entirely new designs of generators have been necessary to meet the requirements. In some cases the speed is fifteen or twenty times as great as would be required for the same size of dynamo driven by a reciprocating engine, and this fact has seriously prevented the attainment of the fullest success so far in the design of direct-current generators of large size for turbine operation.

On the alternating-current side the most striking change in generator design has probably been the reduction of the revolving poles from forty-eight, or even higher in some cases, to four or even two. Such a change involves many new designs before the same close agreement in the performance of similar machines can be reached, in comparison with older types of dynamo. Considering the short time in which designing engineers have been at work upon turbo-alternators as contrasted with "standard" direct-current and alternating-current machines built for slower speeds, it is evident that excellent progress toward uniformity has been made when we compare like machines under test.

Thus, two 500-kilowatt, two-pole, sixty-cycle alternators of the same make recently tested for a turbine power station were found to agree quite closely in performance. When running at their normal speed, 3,600 revolutions per minute, and excited to normal potential, 2,300 volts, the rise in voltage from full to no load at 100 per cent power-factor was 10.6 per cent in machine A and 9.8 per cent in the case of machine B. When excited to 2,000 volts the rises were sixteen and fourteen per cent respectively. At eighty per cent power-factor—about as low a figure as would be likely to occur on any modern system, even for a short time—with excitation to 2,300 volts the full load to no-load voltage rise was 25.6 per cent in A and 23.6 per cent in B. With excitation to 2,000 volts at eighty per cent power-factor the rises were 34.5 and thirty-three per cent. Such close agreement as this argues well for the successful operation of the machines in parallel. Comparatively little difference is seen in the amount of current required for field excitation. At non-inductive full load one alternator required 49.9 amperes in its revolving field, and the other 52.5 amperes. At eighty per cent power-factor and full load A required sixty-one amperes and B 64.2.

The efficiencies under test were also interesting in their substantial agreement. At twenty-five per cent of normal load A developed an efficiency of eighty-six per cent against eighty-five per cent for B. At half load the figures were ninety-two for both machines, and the guarantees were exactly equalled. At seventy-five per cent of normal load A's efficiency was 94.3 and B's 94.4 per cent, the guarantees being ninety-four per cent. At full load the test showed 95.2 and 95.4 per cent for A and B, the guarantee being ninety-five. At twenty-five per cent overload both alternators gave ninety-six per cent efficiency. These figures were quite as close in agreement as those of the exciters purchased for the installation, and when one considers the difficulty in getting precisely the same magnetic characteristics and mechanical dimensions in two generators of similar design, the comparative newness of the bipolar turbo-alternator and the possible accuracy of the tests, it is evident that these machines have reached a very high standard of reliability in design.

A GOOD FIELD FOR THE FLAME ARC LAMP.

The flame arc lamp, with its enormous volume of light and its brilliant yellow color, has heretofore been used mostly for advertising purposes, where the light is not only useful, but the striking character of the lamp is intended to attract notice. There is, however, one field in which this lamp may be used, and is being used, most effectively. This is for lighting ground where work is being carried on at night. In New York city the work of building terminals for the tunnels under the two rivers is being pushed as rapidly as possible. Night work is, of course, the rule, and here, in one case, at least, the flame arc is a great help. A number of these lamps are suspended well above the ground, and the quantity of light given out makes it possible to carry on the work almost as easily by night as by day. For such work the yellow color of the light seems rather to be a help than an objection, since nearly all the materials handled are brown or yellow, and hence reflect a larger portion of the light than would be the case were the mercury arc or the ordinary arc lamps employed. The effect of these lamps is very striking. In approaching the place at night one seems to be coming out of a dimly lighted passageway into a spot brilliantly lighted by the summer sun.

ELECTRIC DOCK EQUIPMENTS.

For carrying out the work of handling materials in large manufactories or ship yards, the electric motor seems to have driven out all competitors. When the area to be covered is large, or the distances of travel great, the ease with which power may be delivered to the electric motor gives it a great advantage. The same is being found true in other situations where a large amount of material must be handled expeditiously. This is particularly the case in large shipping docks, where cranes of all types are necessary to handle large freight, and conveyers for handling smaller packages. Here also electrically driven capstans prove invaluable for warping vessels into the dock and for moving cars on the railway sidings. It is noteworthy in some cases that the electric motor has driven out of use its steam and hydraulic competitors, because it works quickly, can be overloaded safely, and is easily moved from point to point

What Hath Been Wrought.

A Quarter Century's Progress in the Applications of Electricity.

By the Technical Editor of the ELECTRICAL REVIEW.

WHEN, in the spring of 1844, Morse completed the first magnetic telegraph line in the world, and thus started the thin edge of a wedge, the effects of which were destined to be felt throughout all branches of human activity, the first message sent over the line was, "What God hath wrought." This issue of the ELECTRICAL REVIEW commemorates the twenty-fifth anniversary of its establishment, and it therefore seems proper to glance back over these years and see what hath been wrought in this quarter-century. A complete review of all branches of electrical application would fill many volumes, but it is possible, in a limited space, to bring out those phases of this marvelous growth which have been most significant.

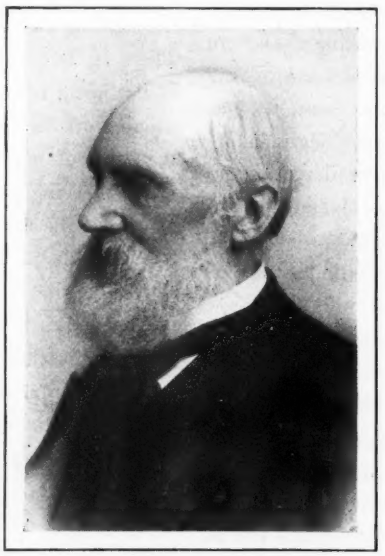
In order to understand fully this development, to see wherein it differs from that of other industrial advances, it is necessary to glance still further back and see what were the conditions during the period preceding 1882.

Electrical phenomena, in some form or other, have been known for ages, but they merely called forth comment from the early philosophers. In the last half of the eighteenth century frictional electricity began to attract the attention of students of natural philosophy of those days, but it is not probable that continued investigation of this phase of electrical action would have produced results of much every-day value. In fact, it is only very recently that static electricity may be credited with practical applications.

But an accident noticed by Galvani started research in another direction, and through the efforts of Volta and others, produced the primary battery, our first source of electricity in quantity. This was a mighty step forward, because now it was possible to obtain electrical energy in large quantities. But there was one defect fatal to the application of the new power in industry: The power thus obtained was costly.

This defect, however, in no way interfered with the scientific study of electrical phenomena. There were, of course, in those days no mechanisms capable of utilizing this power, but these were forthcoming before very long. The galvanic battery was devised in the last year of the eighteenth century. The magnetic effect of galvanic currents was noticed, and the electromagnet was invented during the next twenty-five years. Given a battery and an electromagnet, motors could be, and were, constructed. But the cost of the electric current prevented these from being employed in other than experimental uses, and the development of the motors was not carried far.

There was need then for the next step in advance, a step which would give us a cheap means of obtaining electrical energy. Whether this need was distinctly felt can not be said, but there were not wanting inquiring minds who asked the question, if an electrical current produces motion, may not this action be reversed;



LORD KELVIN,
Scientist and Philosopher.

is there not some way of moving a device so that a current will be started? It was Faraday who answered this question, after a dozen years of constant effort. He found a method; he discovered that a current could be started by moving a body in a magnetic field, conditions, of course, being such that the current could flow. This was in 1832. It constituted another of the great stepping stones, but there still remained the next: Means must be found for putting Faraday's discovery into practical form. This was not forthcoming until 1868, but during this period progress was being made in other directions. The telegraph was invented and progress made in other directions, so that when Gramme devised his dynamo its significance was immediately recognized, and thereafter progress went on at a vastly greater rate. The fact that this mechanism was reversible, and could be used as a motor, was soon discovered, and thus all the essentials for applying the new power to every-day work had been brought forth. It must be recalled also that Faraday discovered the principle of magnetic induction, which laid the basis for alternating-current transformation. Previous to Gramme's invention magnetic dynamos had been in use, but they had not led to much advance in the art of producing electrical energy.

Thus, in the early seventies of the last century, the principles of electrical application had been evolved, and there only remained the working out of systems, the improvement of devices so as to make them practical, and the devising of methods to reduce the cost of the new power, however used, to a point where it was feasible to introduce it.

By this time the telegraph was well established both on land and under water. The next steps were the invention of the speaking telephone by Bell, and the devising of a system of arc lighting by Brush. These were followed by the incandescent lighting system of Edison. These three applications had been worked out and were just gaining a foothold when the first issue of the ELECTRICAL REVIEW appeared. The telephone of those days used the Bell receiver and a battery transmitter; the switchboard was in the first stages of development; practically all circuits used the ground return, and all wires were overhead. There were about 180,000 instruments in use in this country, an exceedingly satisfactory showing for the first six years of growth. Various systems of arc lighting had been more or less perfected. All employed special dynamos of peculiar design and an open arc lamp. This system of lighting was being introduced for street illumination. Various features of the incandescent system had been worked out after much labor, and the first central station was being constructed. In fact, it was on September 4, 1882, that the Pearl street station of the Edison system in New York city was opened. Thus three important applications had been started through the tireless efforts of inventors who seemed proof against all disappointments and discouragements. Their foresight was good; they had perhaps played the most important part in opening what will certainly

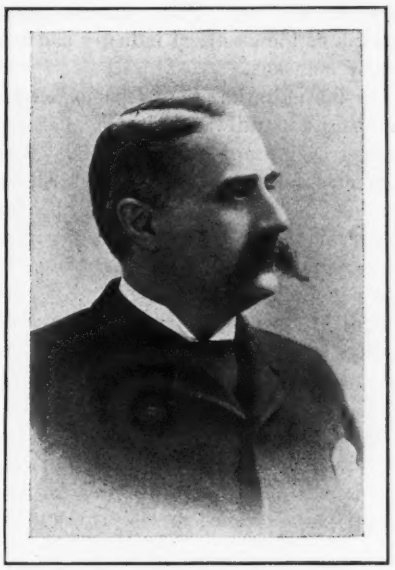
be known as the electrical era. Yet they could not have dreamed how wide the influence of their work would be; how it would be felt throughout the entire civilized world and would leave untouched hardly a single line of human endeavor. At that time there were also others who believed that the new power could be applied in other ways. And yet the electric motor was a toy.

The next year, 1883, is significant, because it was then that the first promising attempt was made to apply the motor to railway work. Siemens Brothers, of Germany, during this year opened a small third-rail system at the Giants' Causeway, Ireland, and at the Chicago Exposition an electric locomotive was shown by Edison and Field. Leo Daft built a small electric line at Saratoga Springs, N. Y. These were the first experiments with the electric railway on a practical scale, but it was not until some years later that a system had been sufficiently developed to enable it to enter into competition with other methods of traction. The year is nevertheless significant as marking an important phase of development, for it was then that the system was brought to public notice.

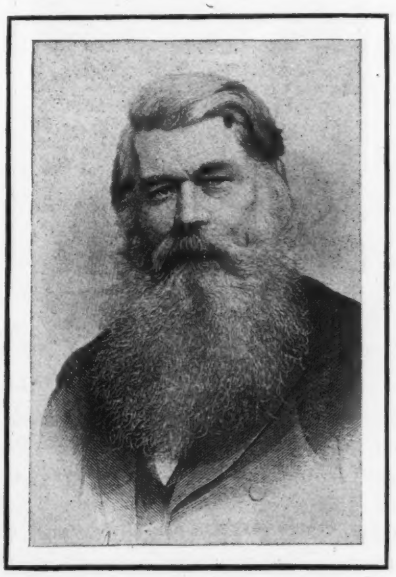
The next year, 1884, witnessed further efforts to perfect an electric railway system. The Siemens Brothers again took an important step by introducing an electric system on a horse-car line connecting Berlin and Charlottenburg. The first conduit system was laid down in Cleveland, Ohio, by Bentley and Knight, while the forerunner of the trolley system was constructed by Henry at Kansas City., Mo.

At this time the new systems were attracting considerable attention, and this was much increased by the electrical exposition opened in Philadelphia, Pa., under the auspices of the Franklin Institute. This not only opened the eyes of the public to the possibilities of the electric motor, to the importance of the telephone and the electric lighting industries, but it resulted in an important movement. A national congress of electricians had been authorized by the federal government, and the bringing together of men from all parts of the country who were interested in applications of electricity and the study of electrical science resulted in the founding of the American Institute of Electrical Engineers, a society which has played an important part in the history of the electrical industry. The year 1885 also witnessed the founding of another influential electrical society—the National Electric Light Association.

During these years the electric lighting industry, as well as the telephone, were making much advance, but it was mostly in the perfecting of the systems, and no great event stands out. The electric railway, however, was still in the experimental stage, so that undertakings, though really small, were of comparative importance. It was during 1885 that the first commercial electric railway was started in this country—a short line between Baltimore, Md., and Hampton. The system was installed by Daft. It employed a central third rail, and the cars were drawn by small locomotives which replaced horses. It operated with some success for over a year, but finally was abandoned, as it had fallen into disrepair. During the same year an underrunning trolley was tried on a short road at Toronto, Ontario, and Frank J. Sprague read a paper before the American Institute of Electrical Engineers discussing a proposed electrical equipment for the elevated roads in New York city. During 1886 Sprague carried out experiments on the elevated, placing his motors on the car trucks; but it is the year 1887 which marks the closing of the experimental era of the electric railway and the opening of the actual introduction of the system, for it was then that Sprague made a success of an overhead trolley system installed at Richmond, Va. The undertaking was large, as there were fourteen miles of track. The system adopted was essentially that known as the overhead trolley. From this time on the most striking feature of electric railway development has been its rapid and wide introduction. The various parts of the equipment, of course, have undergone much improvement, but it was not until some years later that any radical change was proposed. It is worthy of note, however, that in 1888 Daft operated the Ninth Avenue elevated line in New York city with the first large electric locomotive. His motor was capable of drawing six cars at a speed of forty miles an hour.



CHARLES FRANCIS BRUSH,
Inventor of the Arc Lighting System.



JOSEPH W. SWAN,
Prominent in Developing the Incandescent Lamp.

In the electric lighting industry several significant events had occurred. In 1885 the storage battery was for the first time added to an electric lighting plant, this being at Phillipsburg, Pa. Of late years the storage battery has become an important part of the station equipment. During the same year the Westinghouse Electric and Manufacturing Company was founded as an outgrowth of the old United States Electric Light Company, and has since grown to be one of the great electrical companies of the world. At this time also the same company introduced the alternating-current lighting system devised by William Stanley, and thus started the rivalry between the two systems—alternating and direct—which has not yet ended.

About this time the rapid growth of the telephone systems required so many wires overhead that the necessity for placing them underground was recognized, and the work was in progress.

The next few years were years of great commercial development, but a few important developments stand out. In 1888 Nikola Tesla described his polyphase sys-

tem before the American Institute of Electrical Engineers, thus giving the alternating system a means of competing with the direct-current electric motor, which was somewhat slowly coming into use for small power purposes. During the following year an important step in the utilization of water power for producing electrical energy was taken when a commission was organized to study the problem presented by Niagara Falls. Water power had previously been used for driving dynamos, notably for the Giants' Causeway Railway; but now it was just being realized that cheap electric power was destined to be a valuable boon to industry. Particularly would it bring to cities a much-needed supply. Already the effects of the electric railway upon city life were being felt, and the importance of providing better lighting, both in the homes and on streets, was well realized. Not only was greater comfort to the citizens thus secured, but work was made easier in innumerable ways, and the streets were made safer. There can be no doubt that the electric lighting of streets, as well as the electric railway, have been powerful factors for improving thoroughfares; and, as a result of this, attention was given to cleanliness and sanitary conditions.

In 1889 the Thomson-Houston Company took over the Brush Company, thus beginning a series of consolidations finally resulting in the formation of the General Electric Company in 1892, the influence of which has been wide in developing and introducing electrical methods.

The study of Niagara Falls as a possible source of power marks the beginnings of electrical transmission of power. To be successful, a high potential was essential. The first serious attempt was made in 1891, in California, the pressure then being 10,000 volts. Lack of financial support rendered the attempt a failure, but in the following year a polyphase system was installed for transmitting power to Pomona, Cal., and the year after, 1893, the contract for the first Niagara Falls plant was let, the plans being upon a scale at that time stupendous. The development of 50,000 horse-power was contemplated in generators rated at 5,000 horse-power each, figures which inspired considerable awe in those most familiar with electrical work. This plant was actually put in service in 1895. Power was transmitted to Buffalo, N. Y., and, contrary to expectations, the establishment of metallurgical and electrochemical industries in the immediate vicinity of the power-house created a local demand of much greater importance than that of Buffalo. The possibility of this had been in mind, but it had at first been thought that the transmission of power would be the most important feature. Thus another great branch of the electrical industry had been fairly launched.

In the meantime the telephone, electric lighting and railway industries had witnessed significant developments. Bell's fundamental patent expired in 1893, and during the preceding year independent telephone companies had been organized in expectation of this event. During 1892 also the long-distance system had been rapidly developed, so that then communication had been established between Chicago and Boston.

The most important event in electric lighting was the bringing out of the long-burning enclosed arc lamp in 1892.

In 1893 the World's Columbian Exposition was opened at Chicago, and the

EDWARD WESTON,
Versatile Inventor. Developed the Art of Electrical Measurement.

electrical features of this exposition were noteworthy in many respects. The electric lighting system offered opportunities for decorative illumination which were utilized with wonderful effect, and the electric intramural railway was notable for the size of its equipment. In the early years of development the electrical engineer was hampered somewhat to find a suitable prime mover for his generators. The latter were necessarily comparatively small, and ran at a high speed. Belt driving was necessary, and the demand for well-governed, high-speed engines led to a remarkable development in this branch of mechanical engineering. There were, it is true, exceptions to this method of driving, but throughout the eighties that generally adopted was by belts connected to a large flywheel or through a countershaft. At the time of the exposition at Chicago the increasing size of the generators made it desirable to do away with belting and drive them directly from the engine. Since then this tendency has largely prevailed, so that except for special cases or very small dynamos, the direct drive is almost universal.

An event of much importance which took place during the exposition was the holding of the International Electrical Congress. In this electrical engineers from all parts of the world came together to discuss matters of importance and to hear papers upon new developments. The first steps towards adopting an international system of units were then taken.

The electric railway was now becoming the standard method of propelling street cars in cities. It had practically but one competitor—the cable—and was rapidly demonstrating its superiority over the latter. In 1894 two important steps were taken. One was the construction in Washington, D. C., of a complete conduit system, the conductors being placed under ground and no overhead wires being allowed. This system was introduced later into New York city. So far as the mere moving of the cars is concerned, it presents no advantages; but when the importance of the system warrants the expense, it complies with that desirable condition of avoiding any overhead wires within the city proper.

During this year also the first system of heavy traction was installed on a section of the Baltimore & Ohio Railroad, through the new tunnel which that road had driven under the city of Baltimore. Due to the length of this tunnel and the difficulty of securing ventilation on account of the city's requirements, large electric locomotives weighing ninety-six tons apiece were introduced for hauling the steam trains through the tunnel. This system is still in operation, although there have been some modifications in the type of locomotive employed and in the method of collecting current.

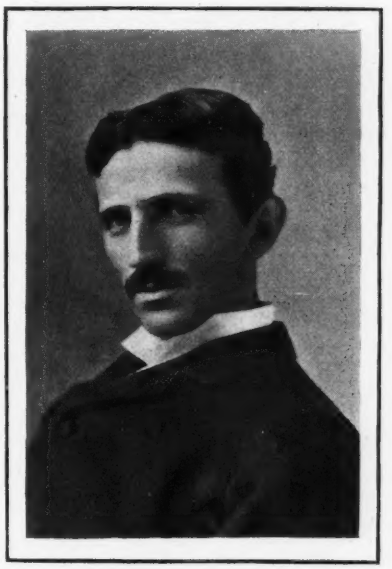
The electric railroads were now reaching from the cities out into the country. They were connecting the neighboring villages with the city, and these were the beginnings of the interurban roads, which have since spread so rapidly. At this time also the system had turned the human tide from the cities toward the

country; it had made it possible to live some distance from the place of working and not waste too much time in traveling to and fro. The suburban sections of all large towns began to grow rapidly. Cities which before had been of secondary importance now became important as places of residence, and the necessity for living in apartment houses disappeared, except in some less fortunately located towns.

During this year, 1894, a discovery was made which rapidly became of incalculable value. It had been noticed by Roentgen that an electrical discharge through an exhausted tube set up some form of radiation which penetrated bodies opaque to visible rays. The ease of penetration varied with different substances, flesh being more transparent than bone. These rays, called by the discover "X-rays," also brought about the chemical action necessary for photographing. Thus it became possible to examine bones and other bodies within living tissue without injury to the latter. The benefit to surgery can hardly be overestimated. The application of this effect has developed marvelously since the discovery, and the X-ray equipment is now one of the most essential appliances for all modern surgery.

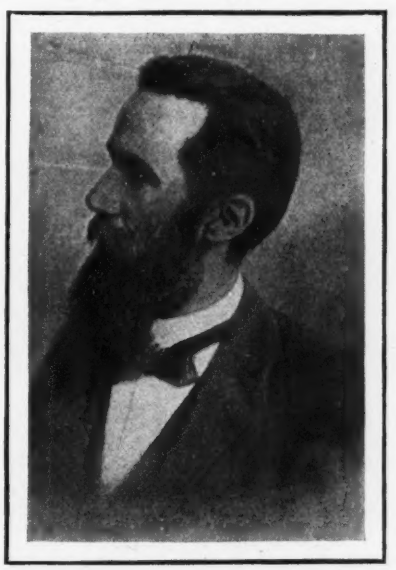
During this year the first use of electrical discharges through exhausted tubes as a means of illumination was made on a large scale. This was the result of the labors of D. McFarlane Moore. To-day his system, in its improved form, is finding wide use in many locations where its peculiar features are advantageous.

During these years of marked activity in the telephone, electric lighting and electric railway industries the telegraph had forged ahead steadily and on a solid basis. Compared with the telephone the development was slow, but this was due to the marvelous rate at which the latter grew. There had been no great changes from the systems well developed previously. There had been devised several methods of machine telegraphy, but none had come into use; in fact, up to the present time, while there are a number of beautiful systems, the old and simple methods are still employed. There had been one change: The introduction by Field, in 1879, of the dynamo in place of the battery, which effected a considerable economy in the cost of power and saved much space in the companies' buildings. But the system was essentially that which had been used for about twenty years. In 1896, however, there came a suggestion of a new system. Late in the eighties Hertz, following Clerk Maxwell's analytical arguments, had shown experimentally the existence of electrical waves in the ether. The possibility of utilizing these for communicating at a distance, without intervening wires, had been suggested; but it remained for William Marconi to devise a system which pointed the way to the



NIKOLA TESLA,
Inventor of the Polyphase System.

solution of this problem. His system, consisting of an antenna in which oscillations were set up by means of an electrical discharge across an air-gap, and a receiving antenna associated with a device sensitive to the electrical disturbances which the



GALILEO FERRARIS,
One of the Prominent Developers of the Polyphase System.

waves set up in it, is essentially the system in use to-day, although numerous inventions have vastly improved the methods of producing oscillations and increased the sensitiveness of the receiver. That used by Marconi was the so-called coherer, a device discovered by Branly. Marconi succeeded in transmitting signals across short distances. His results drew many other workers into this field, and the progress since then has been rapid. Each succeeding year has seen greater distances covered, until, in 1901, Marconi himself first transmitted a signal across the Atlantic Ocean. The following year communication was maintained with the steamship Philadelphia until she was 1,500 miles away from the sending station at Poldhu, Cornwall, and later in the year communication was established between Poldhu and Glace Bay, Nova Scotia. Since then communication across the ocean has been established by others also, but the system has not yet been put into actual service. This method of communication is one of the great achievements initiated during the last part of the nineteenth century.

During 1902 the first cable across the Pacific was laid, thus completely encircling the globe, and the first message was sent around the world. During this year also the first section of the American Pacific cable was laid to Honolulu. This cable was completed during the following year.

Since the starting of independent telephone companies in 1892 this movement spread rapidly. In 1896 the independent companies formed an association to protect their interests. By this time the telephone system had been greatly improved. The introduction of paper-insulated cables had cheapened the construction of underground lines, and the introduction of the central energy system, in which a storage battery placed at the central exchange provides all the energy required for conversation and for manipulating the auxiliary devices, wrought a great improvement. The inconvenient and expensive primary batteries at each subscriber's instrument were done away with, and a marked economy effected in the time required to complete connections.

The underground system, although a marked improvement for special purposes, was of limited application, on account of the static capacity of the cables. Attempts had been made to overcome this by means of neutralizing inductances, but in 1900 Dr. M. I. Pupin brought out a system which made it possible to determine where and how to use these coils. The system was tried both in this country and abroad, and was found to effect a very material improvement in trans-

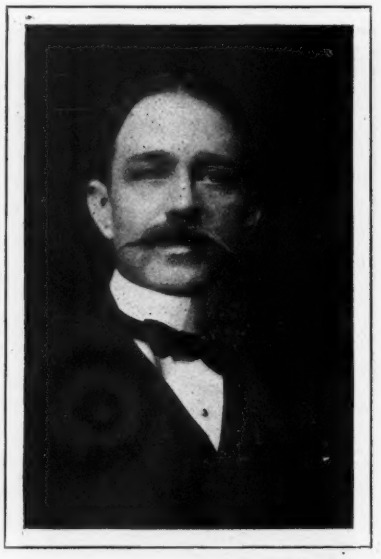
mission over cables, and thus made possible a considerable increase in the length of cable over which conversation may be carried on.

In another field of telephone development much effort was being expended at this time, but no commercial application had been made. This was the perfecting of an automatic telephone system which would do away with the operators at the exchanges. In 1902 an automatic exchange was introduced in Chicago, and in the following year in Dayton, Ohio; Grand Rapids, Mich.; Lincoln, Neb., and elsewhere. While, compared with the manual system, but little progress has been made, it must be remembered that it requires some time to perfect a system so revolutionary in character, and much opposition has been encountered from the advocates of the older method. During the last year or two this system has attracted more attention.

By this time the telephone had spread everywhere. It had reached out from the cities to the country, and was to be found wherever men work; it had brought about almost revolutionary changes in business methods. The output of the individual had been multiplied several times, and armies of messengers had been turned to productive work.

From time to time the possibilities of wireless telephony have received attention, but only during the past year has any real progress been made. The difficulties are very great, but they do not seem to be insurmountable.

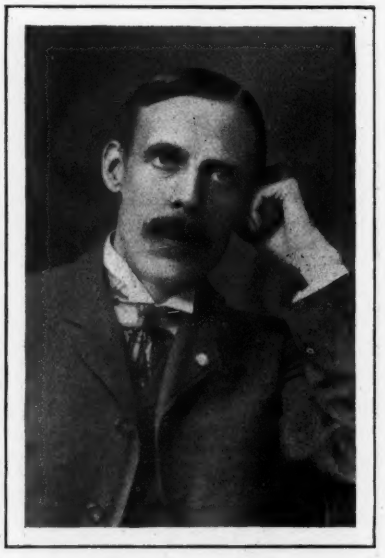
Electric lighting systems had grown until they no longer suffered any comparison with gas. The method of generation and of distribution left little to be desired, and the lamps themselves, so far as effects were considered, were highly satisfactory. There was, however, one great drawback: The efficiencies of the lamps were shamefully low. This is by comparison with other electrical developments, and not with other methods of illumination, to which they are far superior. But it was being realized that something must be done to increase the amount of light obtained from a given amount of electrical energy. The first step was made by Walther Nernst, who brought out, in 1898, the lamp known by his name. A radical departure was made in this, as the glowing body was not normally a conductor of electricity, and only became so when heated. This was a disadvantage, but the white character of the light, as well as its high efficiency, have made it an important factor in electric lighting. The lamp was brought out in commercial form in this country in 1901. In 1899 the enclosed arc lamp was adapted to alternating currents, and the city of Buffalo was lighted entirely from power developed at Niagara Falls, a noteworthy feature be-



PETER COOPER HEWITT,
Inventor of the Hewitt Mercury Vapor Lamp.

ing the use of aluminum wire as conductors.

But the fight for improved lamps still went on, and efforts were made to utilize the increase in efficiency obtained by adding certain mineral salts to the carbons



ALFRED H. COWLES,
Pioneer Worker with the Electric Furnace.

of the electric arc. This produces a luminous flame, in contrast with the plain carbon arc, which produces light merely by raising the tips of the electrodes to incandescence. In 1902 this type of lamp was taken in hand, but it was several years before it emerged from the laboratory and appeared upon the street. In 1903 another solution of the lamp problem was offered by Peter Cooper Hewitt in his mercury vapor lamp, which has a high efficiency, though a peculiar color. In the following year the magnetite arc was brought out, a variation of the flame arc, though using metal electrodes instead of carbon.

So far, with the exception of the Nernst lamp, all improvements had been limited in the arc lamp, although as a transformer of energy it was much superior to the incandescent lamp, but now a great stride was taken when the tantalum filament was brought out by H. Von Bolton and Feuerlein. In this a highly infusible metal replaced the carbon filament and gave an efficiency much better than that of the latter. Other inventors had previously attempted to improve the incandescent lamp by coating the filament with various materials or by replacing it; notably the osmium lamp, but for various reasons these never became of much importance. The tantalum lamp was, however, the first of of a number of improvements, so that there are to-day several types of incandescent lamp far better than the standard carbon lamp. The introduction of these lamps is just taking place, and the effect can not but be great. The cost of illumination by this means will be materially reduced, which will, of course, lead to a wide expansion; and, at the same time, the output of every station, rated in lamps, will be correspondingly increased.

The steam turbine, which had languished for many years, now became a factor in central station design. The tendency towards increase in size of units had gone steadily forward, so as to benefit by the higher efficiency of large reciprocating engines. The steam turbine checked for a time this tendency by offering an efficient prime mover in smaller sizes. Moreover, the character of the drive was excellent for this purpose, and the small floor space brought about much appreciated economy in the station design. By this time the central stations had become large and complex. High-tension distribution had been generally adopted for large cities, current being transmitted to substations and there transformed into the kind desired.

Along with the growth of the electric lighting industry went the spread of the electric motor as a means of driving machinery. This took place not only in small shops and other places where it was inconvenient to employ steam or other power, but in large workshops, in factories and everywhere where many machines are

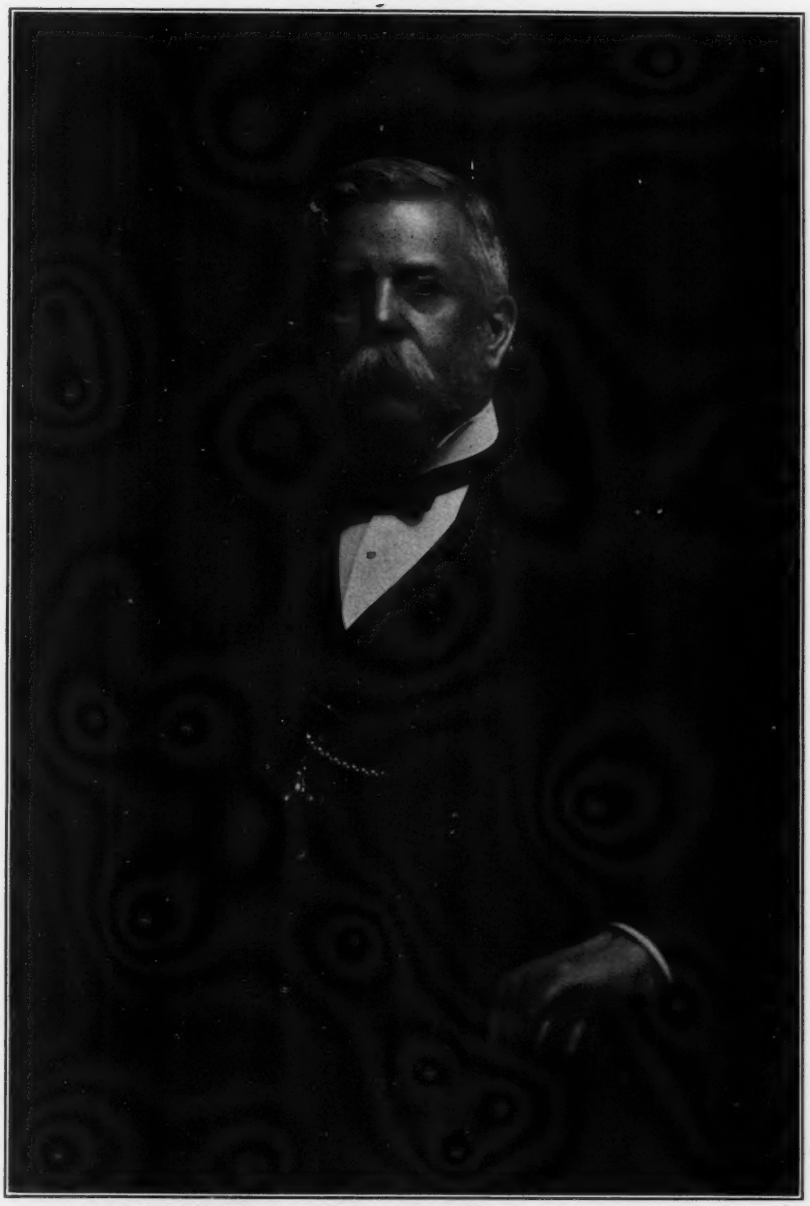


PHOTO BY GESSFORD, NEW YORK

Mr. GEORGE WESTINGHOUSE

President of the Westinghouse Electric and Manufacturing Company

One of the world's foremost inventors, manufacturers and organizers

driven. The old plan of driving from a line shaft by means of belts involved many disadvantages not incident in the motor drive, but a feature of more weight than this was the fact, soon realized, that the individual driving of tools made possible an increased output of the shop and improved the quality. The year 1899 is notable for the introduction of the electric motor in the abattoirs of the firm of Armour & Company, Chicago, and also on two battleships, where it replaced the old, inefficient small steam engine. To-day this system has become the standard for factory driving.

The advance in electric railways during the past few years has been in several ways. A still greater expansion of the interurban and suburban lines has brought this system in competition with steam roads; on the other hand, the steam railroads themselves have been forced, in some cases, to turn to electric traction to overcome certain local difficulties, and this has led to the development of enormous locomotives. The work was first started in New York city, where the conditions were particularly acute, and the year 1902 marked the letting of the contract for the electrification of the New York Central & Hudson River Railroad's New York city terminal. The following year the Pennsylvania Railroad decided to pass under New York by means of a tunnel, using electric traction for this purpose. Another important railway event during 1902 was the bringing out by the Westinghouse Electric and Manufacturing Company of a single-phase railway system. Since then several lines have been installed using this system, and the New York, New Haven & Hartford Railroad has adopted it for its New York city terminal.

During this year some highly interesting experiments were conducted at Berlin with high-speed traction. A motor-driven car was run at a speed of over 130 miles an hour. As yet no practical results have followed these experiments.

During these last years of electric railway development another important system was brought out by Sprague, which he called the multiple-unit system. This was first used on the South Side Elevated in Chicago, in 1899. In brief it consists of adding a master controller to each car, which operates the main controller. The master controller will operate at the same time the main controller of one or any number of cars, so that trains may be made up of any length desired, each complete in itself, and all controlled from one point. This method made possible the conversion of the elevated lines in Chicago, New York and elsewhere, where it is necessary to run trains of cars, and led to the abandonment of steam trains on elevated roads in this country. Other important installations of the multiple-unit system have also been made on surface lines.

CHARLES MARTIN HALL,
Inventor of Aluminum Reduction Processes.

High-tension transmission, which was started in 1902, had grown steadily, the distances of transmission had increased, and voltages had gone up. Water powers previously useless, since they were not accessible, were harnessed, and the power thus developed transmitted to places where it could be used. The success of the Niagara plant started in 1905 led to other installations at that point, so that there are now about half a dozen power-houses with an output of over half a million horse-power. In California, where fuel is scarce, and water power available, as well as in other western states, the most rapid advance was made. In 1901 the transmission voltage had risen to 60,000, and power had been transmitted 225 miles. A year later 80,000 volts was tried in Montana, but 60,000 seems to be the upper limit with the present methods of construction. In 1905 power was incidentally transmitted over a distance of 300 miles in California. The success of the western plants led to a great development in the East, but here the distances are less and the systems employed are less impressive, though not less important. To-day the water powers of a state have become one of its most valued assets, due to the development of high-tension electrical transmission of power.

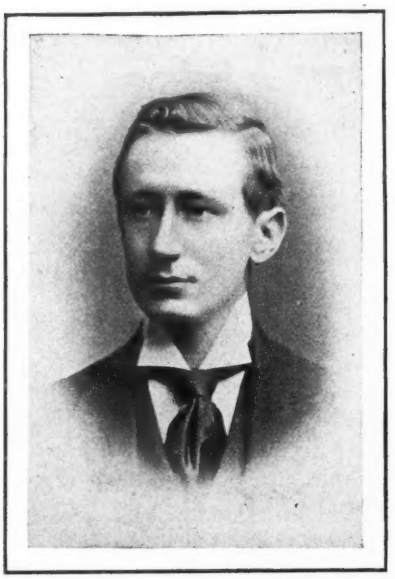
CHARLES P. STEINMETZ,
Inventor, Engineer, Author.

Electrochemical applications, with few exceptions, were not possible commercially until large sources of cheap power were available. Before the opening of the Niagara Falls plant electroplating and a few other smaller industries constituted the whole, with the exception of the storage battery, which hardly belongs in this class. That, it is true, had been greatly improved, but the old Planté and Faure types, modified by various methods of construction, were still in use. The adding of the auxiliary to the power station made necessary the development of a new branch of the art of storage battery engineering, necessary in order to adapt the peculiarities of the battery to the conditions obtaining in the station. Some very remarkable engineering work has been done in this direction. Many attempts have been made to substitute other materials for the lead and sulphuric acid of the battery, the latest and the most important being that brought out by Thomas A. Edison in 1901, in which nickel and iron take the place of the lead. This battery has, of course, required some years to demonstrate its commercial advantages. Along with the improvement in storage battery construction, went the development of the electric automobile, which has to-day become a most important factor in city traffic and which promises to work still greater changes in city life.

The opening of the first Niagara Falls plant started electrochemical developments of great magnitude in other lines. It was here that the large calcium carbide works, carborundum furnaces and furnaces for making artificial graphite from coke were established; and here eventually came the

Pittsburgh Reduction Company with its method of producing aluminum. The work of this company converted aluminum from a curiosity in chemical laboratories to a common metal for use in the arts.

During these years of development, while the electrical arts were being



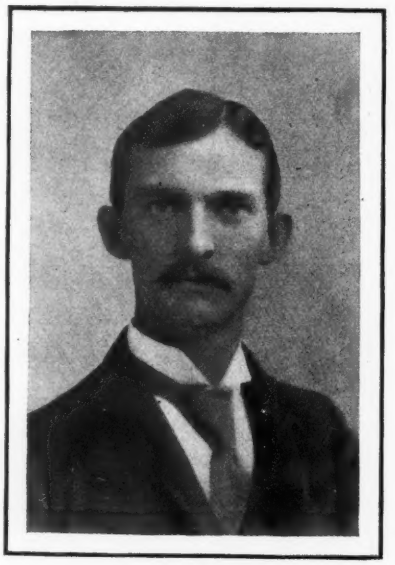
WILLIAM MARCONI,
Inventor of Wireless Telegraphy Systems.

changed from the empirical methods of the pioneers to the scientific systems of to-day, a most important feature was the development of the art of electrical measurements. In this work a preeminent part has been taken by Edward Weston, who, with others, has placed electrical engineering work, in this respect, on a plane where it stands almost alone.

There have been a number of highly interesting applications of electric power within the last year or two, notably the invention of the teleharmonion, a device for producing and transmitting music.

To-day there are two features of electrical development which are most impressive. One is the wide spread of electrical methods. Almost every industry employs this power in some form or other. In practically every line of human activity, the electric motor, the electric lamp, or some other device, is an important factor. The other feature is the enormous commercial development which has taken place. Certainly no other field of human activity can show such a record. Absolute statistics for the present year are not available. The latest compilation was made in 1902 by the Bureau of the Census, and from this some idea of the situation at the present time may be obtained. For example, at that date there were 3,620 central electric lighting stations, representing a cost of equipment of $505,000,000. The yearly income was nearly $86,000,000. This showed that the development during the twelve years preceding the census had doubled the investment as well as the income. The horse-power in dynamos at these stations was 1,600,000, and the output 2,500,000,000 kilowatt-hours yearly. These stations employed a small army of 30,000 workers, to whom $20,000,000 was paid in wages. Eighteen million incandescent lamps were in use, and nearly 400,000 arc lamps.

The figures for the electric railway are still more astounding, and here too the investment and income had about doubled during the twelve years preceding the date of the census. In 1902, 987 com-



OLIVER BLACKBURN SHALLENBERGER,
Prominent in Developing the Alternating-Current System.

panies operated systems having over 22,000 miles of track, and representing a cost of construction of nearly $2,200,000,000. They employed 140,000 men, and transported nearly 5,000,000,000 passengers.

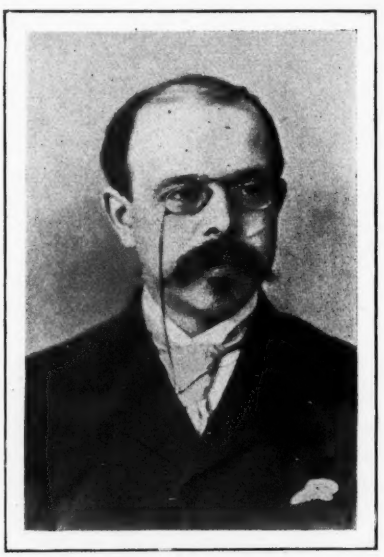
The telephone systems were serving in 1902 nearly 2,300,000 subscribers, and were earning $87,000,000. They paid in wages $36,000,000 to their 79,000 employés. The cost of construction of these systems was over $366,000,000.

Compared with these figures the extent of the telegraph development is small, but actually it is very great. There are in this country twenty-five systems, which cost $157,000,000. The 28,000 employés earn $15,000,000 a year.

The newer developments, as mentioned, practically doubled during the twelve years ending 1902, and since then the development has been at a greater rate. The telephone and electric lighting industries have about doubled, the electric railways have increased about forty per cent and there have been corresponding increases in all other branches.

To supply the needs of these various systems large manufacturing establishments have grown up, whose business has become an important factor in the commercial world. The latest figures obtainable for this growth were given in the census report for the year 1905. During that year the value of the products, of all kinds, turned out, was nearly $160,000,000, this representing the factory cost, and not the selling price. The same census shows that at that time the general manufacturing industries were utilizing 1,138,000 horse-power in electrical machinery, out of a total of 14,500,000. This shows to what extent electric appliances have been introduced into the manufacturing arts; and the actual effect is greater than that indicated by the figures, as it must be remembered that a considerable part of this power is in places where the electric motor can not compete.

Certainly no other class of industries can show such stupendous growth as that demonstrated by these figures, and certainly there has been no other which can compare with the introduction of electric power, in all its forms, in its far-reaching influence on the civilization of to-day. What will be the result of the present tendencies, none can say. That the growth will go on at the present rates is hardly



WALTHER NERNST,
Inventor of the Nernst Lamp.

believable, yet one can not see anything ahead to interfere with it. There is little doubt that the influence of these new methods will be one of the controlling factors in advancing civilization, in bringing to each and all more leisure and greater comfort, and in relieving us and our servants, as it has already done, of much of the drudgery of manual labor.

Nothing has been said of the marvelous advances in physical science, particularly in the study of electrical phenomena. The work of Thomson, Lorentz, Curie, Rutherford and others has carried us far in this direction and done much to mold our ideas of nature and of nature's laws.

The Arc as a Source of Light.

By Elihu Thomson.

THE large growth in the application of the electric arc in lighting may properly be regarded as having had its beginning about twenty-five years ago. At that time the electric lighting station in cities was a new development. It was chiefly based upon the use of arc lamps on constant direct-current circuits from arc dynamos. The lamps themselves were always of the open-arc variety. There were, it is true, a few installations, particularly abroad, where alternating-current arcs were used, and that peculiar but ephemeral form of it, the Jablochkoff candle, had not yet faded into extinction, though its existence was already flickering.

While the open arc held its place for about one-half of the period, during the latter half or within the past twelve to fifteen years the art has undergone more and more radical changes, by the introduction of the direct-current arc enclosed so as to limit the combustion of the carbon electrodes, followed by the enclosed alternating arc, and the various kinds of luminous or flame arcs of the past few years.

There are several ways in which the electric flux known as an arc may produce light.

1. The solid ends of the electrodes themselves become incandescent and radiate light. In the open carbon arc this constitutes the chief source; in the enclosed form it is of relatively less value; and in the luminous arc the incandescence of the ends of the electrodes contributes but slightly to the general result. The possible temperature of the ends of the electrodes being limited by their temperature of vaporization, the luminosity of the carbon in the open, as in the enclosed, arc is directly dependent on the temperature of sublimation of carbon, since carbon passes from solid to gas without intermediate fusion.

2. Light evolved from the arc stream or flame between the electrodes considered as an incandescent gas. Usually this radiation is selective, *i. e.*, it is more concentrated in certain regions of the spectrum than in others, and depends on the wave lengths and intensities thereof given by the vapors present when heated to the temperature of the arc at atmospheric pressure. In the open carbon arc, the heated gas stream is carbon vapor mingled on the exterior with the gases of the atmosphere and the products of combustion of carbon. The spectrum of carbon is not rich in lines, and the radiation as a whole from carbon vapor and the other gases present does not greatly add to the other light emission from the incandescent solid carbon. In the enclosed arc the combustion is restricted, and for a given watts consumption of energy the current is reduced and the potential is increased, owing to the increased length of arc. Assume an open arc of ten amperes and fifty volts with a consumption of 500 watts; the enclosed arc of the same energy consumption would have, say, 6.25 amperes and eighty volts. Here the light

Elihu Thomson.

from the incandescent ends of the electrodes is reduced relatively to that from the gas stream, which stream is now much greater in length. While the longer arc permits more free emission from the hot ends of the carbons, those ends instead of burning, as in the open arc, to a tapered form, are nearly flat for the full diameter of the carbon and this form tends to neutralize the effect of the lengthened arc in allowing unhampered radiation. In the luminous arc, the luminous radiation from the gas stream varies greatly with the materials present and may constitute the greater part. This is the case when metals like iron or titanium are present, the spectra of which are exceedingly complicated, being full of bright lines from one end of the spectrum to the other. In fact the gaseous radiation takes on the characteristics of the metal spectrum to a large extent, and the color of the light emitted will depend on the predominating wave lengths in the spectrum. Some spectra may be deficient in yellow or red, while others may be equally poor in green or blue. The most satisfactory light for all purposes is that under which animal life on the earth has been evolved, and sunlight must therefore remain our color standard. So long then as our illumination is for the general purpose of vision and not for advertisement or special effects, a white light will be needed, and if it is to be obtained from a gaseous arc the materials present must furnish light of all wave lengths. Iron and titanium not only satisfy this condition, but the intrinsic brilliancy of the spectrum as a whole is high, so that economy of light production results.

3. A further source of light in an arc is the entanglement of solid particles in the outer envelope of the gas stream, which particles, if of a highly refractory character, may, when sufficiently dense, constitute a very effective medium for the emission of light waves. They correspond in function to the color particles floating freely in the ordinary luminous sheath of a hydrocarbon flame, as of gas or oil. They may be furnished by vaporization and condensation of substances contained in either or both of the electrodes of the arc.

4. The particles entangled in the outer arc sheath and heated to an incandescence therein, may possess the property of selective radiation in the same sense that such selective radiation exists in the material of the Welsbach mantle. It may well be doubted if this action, whatever its real nature, occurs aside from a region where active chemical changes are taking place, or the oxidation and combustion of gases. The writer has at other times called attention to the probability that the selective radiation in this case may depend upon gaseous union in the pores or upon the surfaces of the solids involved.

In the open carbon arc no light is given by floating particles in the arc stream, for the products of combustion are pure gases, and the carbons, unless impure, yield only these gases when united with oxygen of the air. In the enclosed arc, however, it is conceivable that the oxygen may be so restricted that some carbon particles condensed from the central vapor stream may float in the outer sheath of this stream

before meeting with oxygen enough for combustion. In fact with a too restricted supply of oxygen an enclosed arc will deposit soot upon the upper part of the glass globe surrounding it, just as a kerosene lamp given a too restricted draft will deposit unburned soot or carbon. The most effective enclosed carbon arc is, therefore, one which is almost, but not quite, capable of soot deposits. But as this condition is somewhat critical, practice generally provides a sufficient excess of oxygen to secure clear burning. The smoke deposits of the luminous arc show that even when the gaseous stream itself is rich in light, or efficient as a light source, the volatilized and oxidized products leaving the arc in a fine state of division and, floating as incandescent solids in the arc stream, often contribute considerably to the luminous yield. Unfortunately such smoke is carried out of the arc and must either be caught in smoke receptacles or allowed to escape into the air. This objection would, in the absence of a knowledge of the efficiency of the light production inherent in various kinds of luminous arcs, become a sufficient deterrent in attempts at practical utilization.

In the present day efforts to increase the luminous yield for a given energy expenditure, the question of efficiency of electric arcs of different types becomes often controlling. It is well known that the efficiency of the direct-current enclosed arc is only about two-thirds of that of an open carbon arc consuming the same energy. The cause of this is to be found chiefly in the substitution of potential (gaseous stream length) for current strength (crater area). It is also well known that the falling off in carbon arc efficiency is far greater than in a direct proportion to current strength, so far as solid electrode emission is concerned. In other words, a larger current arc is more efficient in light production per unit of current than a smaller current arc. This may be due to the conservation of heat which is relatively more freely lost by conduction and convection in the smaller arc.

In the alternating-current carbon arc also, as compared with the direct-current carbon arc, there is a loss of efficiency due to the average temperature of the emissive areas of the solid carbon ends being less; not being sustained at equal values throughout the wave, and actually losing all support at the zero of current. Hence it should not be surprising to find that the alternating enclosed arc is not much superior, except as to color of light, to the better types of carbon filament incandescent lamps, as a converter of energy into light. When, however, we turn to the consideration of luminous arcs we find that efficiencies of light production even exceeding that of the direct-current open carbon arc two or three times are obtained. In these not only is the gas stream itself strongly luminous, but its outer sheath is loaded with a cloud of fine particles in a highly heated state and possibly selectively radiating. The luminous arc is essentially an open arc in the sense that if enclosed the glass receptacle must be large enough to allow the smoke to be carried away and to prevent obscuration by deposits.

Broadly, there may be said to be in existence two types of luminous arcs. First —Those in which the electrode is of carbon, which confers conductivity, loaded with compounds which do not necessarily conduct, such as fluoride of calcium. Second—Those in which the electrode is a mass of conducting material which itself furnishes the arc stream with luminous gas and particles.

This is a somewhat artificial classification as both types may be blended. Where the electrode is of carbon loaded as above, it necessarily has a short life, comparable with that of a carbon pencil in an open arc, or say six to ten hours, more or less, according to its diameter and length. Where the electrode is a conducting oxide, or forms a conducting oxide of a solid character during operation, the life of the electrodes may be made such as to constitute a long burning lamp, comparable in that respect with the enclosed carbon arc. Of such character is the magnetite lamp, due to Dr. Steinmetz, who has pointed out the fact that the electrode which is negative generally furnishes the conducting ions in the arc stream, and that these ions may be, as in the case of iron, an effective light source. In other cases the luminous matter may arise from a positive electrode loaded with vaporizable material, which, while not conducting the current, is simply caught in the arc stream, adding to its luminosity and also providing a sheath of highly incandescent particles. As a Bunsen burner flame is rendered luminous by dusting into it powdered magnesia, so these substances enter the more feebly luminous arc stream and enhance its brilliancy. Even the carbon arc stream, which is ordinarily low in luminosity, may be rendered highly luminous by loading the electrodes with solid vaporizable material. But in doing this there is a sacrifice of the luminosity of the positive crater, which is cooled by the absorption of energy needed for the vaporization. The crater then becomes a less prominent feature of the arc emission. Notwithstanding this loss the general efficiency of light production may have become greatly increased.

The most recent work in the direction of arc lighting has been to conserve the efficiency of the luminous arc, to minimize the disadvantage of smoke, and to increase the life of the electrodes so as to save the necessity of frequent trimming. At the same time attention has been given to securing a reasonable color of light and steadiness.

In spite of the magnificent advances which have been made in the incandescent lamps of high efficiency, which will doubtless in many cases supplant indoor arcs, the modern luminous arc will probably for a long time continue to remain the most efficient of all electric light sources, and will hold its own in the lighting of large spaces, particularly outside of buildings.

In such a general consideration of arc lighting as this reference should properly be made to the mercury arc lamp. The recognized efficiency of this lamp seems to depend upon the absence of the lower rays of the spectrum. The red rays naturally demand more energy, or represent more energy, than do the higher rays. Hence if a certain relation now exists between the energy which goes to heat as such and that which goes to light (the greenish light of the mercury arc), it seems doubtful if the red rays could be added without a like proportion of heat rays, and as these rays are relatively more costly, the amount of heat might be so increased as to rob the mercury arc of its present high efficiency. Aside from its defect of color, the mercury arc lamp possesses the unique advantage that the light is spread over an area, and requires no translucent globes to soften its brilliancy. Its characters are maintained in different sizes of lamps and adaptation to different voltages at the terminals can be made in the length of the arc stream. It is not, however, in its simplest forms, adapted to alternating currents, for the mercury arc is itself inherently rectifying. The light consists of specific wave lengths as examined by the spectroscope; namely, the spectrum of mercury vapor, and there is little light in the spectrum between the strongly marked and widely

isolated bright lines in the green, blue and violet. This discontinuity of spectrum would make it a poor light even for examination of colors within its apparent color range. The light of the mercury arc has, however, proven to be very easy on the eyesight, and has laid emphasis on the fact that high intensities of red rays are decidedly trying if not positively injurious. Continued exposure to some of the very intense red luminous arcs used for advertising purposes might show this to be the case.

Ordinary color blindness consists in the absence of the impression of red, and the mercury arc should therefore, to the color blind, represent nearly normal light and be fairly satisfactory. Solar white, however, is and must be the standard toward which incandescent lights, arc lights, and other forms of illumination will approach, for color balance is as much a factor in normal seeing as is intensity of illumination.

An Electric Lighting Retrospect and a Prophecy.

By W. W. Freeman.

THE history of electric lighting developments during the past twenty-five years is substantially the history of the entire industry.

Through invention and commercial enterprise an industry has been built within this space of time that has already discounted centuries of effort in other lines, and yet it is believed that the developments and growth of the early future will greatly outdistance the past record, remarkable as it has been.

The writer has been asked to outline some of the most important causes, inventive and commercial, of the past twenty-five years' development.

In the field of invention there have been many achievements of importance, but the following are probably the most notable in practical and far-reaching results.

THE INCANDESCENT LAMP.

Until the introduction of the incandescent lamp, the success of the electric lighting industry was problematical. The arc light was applicable to many uses, but its field was too limited for general adoption. The use of small lighting units is essential to any general system of illumination and the advent of the incandescent lamp of varying sizes, but uniform attractiveness, furnished the industry its guarantee of permanent success.

The incandescent lamp of improved efficiency is still the prime factor in electric lighting and the chief source of revenue, and unless all present signs fail, marked developments of the next decade will be due to further and most radical improvements in the incandescent lamp.

THE ELECTRIC MOTOR.

With the invention and application of the electric motor, a new demand for electric service was established, and one especially desirable to the companies in enabling them to operate their systems for both lighting and power purposes during the daytime, when otherwise lighting service could only be maintained at prohibitive cost. The power service of most companies is still secondary to that of lighting, except in the case of great power developments, such as at Niagara, but the general use of electric motors aggregating hundreds of thousands of horse-power has been a great factor in the development of the industry, and has likewise helped to reduce the cost of the lighting service.

ARC-LAMP IMPROVEMENTS.

Within more recent years the improvements in arc lamps have established this system of lighting upon a more successful and permanent basis.

For the illuminating of large areas, and where true color effects are important, the arc lamp, as yet, has a field of its own and the constantly increasing efficiency of arc units both in energy consumption and maintenance costs give the arc lamp a high value to the industry.

LOW-TENSION DISTRIBUTION.

The problem of supplying numerous classes of service at different locations by the same system was solved in the low-tension distribution system of Mr. Edison first put into use in 1882.

This important and far-reaching invention effected the distribution of current from furnishing station to customer without intermediary transforming apparatus, and in lighting units independent of each other instead of in series as formerly.

HIGH-TENSION TRANSMISSION.

The limitations of low-tension distribution made it necessary at first to provide different generating stations at short distances, and such stations were of necessity located solely with reference to the area to be served and often to a disadvantage in operating costs. The introduction, however, of high-tension generation and transmission made it possible to locate one large generating station at the most advantageous point for economical operation, without special reference to the areas to be supplied with service, and the current generated as alternating current at high potential is transmitted with small loss to the various distributing points corresponding to the former numerous generating stations, which are changed to transforming or substations, where the high-tension current is reduced to the low-tension requirements, or converted into direct current, for distribution to customers. In this way the combined benefits of high-tension generation and transmission and of low-tension distribution are obtained. The first large lighting company to so change its system was the Brooklyn Edison Company which did so in the year 1897. The plan is now in such general and successful use that it is difficult to realize that its initiation was of such recent date.

The above are perhaps the chief factors which have been furnished by the inventors for the development of this industry, and they have been adequate. With these the commercial builders of the industry have busied themselves and have tried, and with fair success, to make the best possible progress.

The commercial development of the industry, however, in many if not most places has been a matter of public demand rather than stimulated growth. There have been decided exceptions, notably in several large cities, but comparatively few in number.

More recently, however, the commercial spirit has been aroused and as a result the past year's growth has been phenomenal. With this growth, and partly explaining it, there have been developed uses for the service hitherto undiscovered and now, for instance, electricity is recognized as an advertising agency as distinctly as an illuminant.

Heating appliances, medical apparatus, decorative outfits and numerous other applications are becoming more practical and popular with each day.

With the increased demands, and the lesser costs of operation, there have been material reductions in prices charged by electric companies for their service, some voluntary and others enforced, and these

in turn have led to most marked increases in output.

It is the deliberate opinion of the writer that the commercial development of recent years is but the introduction to a proper realization of the application of electric service to the every-day needs of the public; and that the industry has reached the threshold of a near-future growth hitherto unrealized, but the benefits of which every company can share through aggressive, intelligent and systematic effort.

Telephone Retrospection.

By W. D. Sargent.

MY FIRST knowledge of the speaking telephone was in 1876, on a Sunday in July. It was my privilege to be introduced to the telephone and to royalty at the same time—not personally, but within visible distance.

It happened this way: I had been asked by Professor Elisha Gray to assist in an exhibition of his harmonic telegraph in the Centennial buildings at Philadelphia for the benefit, more particularly, of His Majesty, Dom Pedro, Emperor of Brazil, and Sir William Thomson (now Lord Kelvin). At the close of this exhibition an invitation was extended by Alexander Graham Bell to these distinguished personages, and others, to see his apparatus for transmitting speech. The crude apparatus of that day has been described and illustrated many times in the tedious litigation which followed the issuing of the patent.

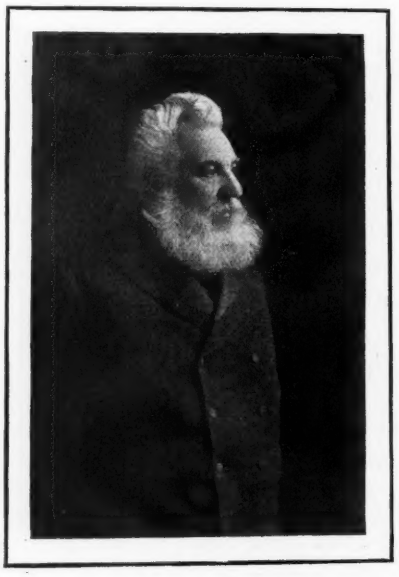
What was most interesting to me at the time was the surprise and delight with which Sir William Thomson listened to speech first transmitted by electricity, and his animated expression in describing the discovery to His Majesty, Dom Pedro, and others.

Sir William Thomson was allowed to carry with him to England a copy or duplicate of the simple apparatus used at the Centennial Exhibition, with the result that all Europe soon became interested in the wonderful telephone.

To my mind the most marvelous thing about the telephone instrument was the discovery that a thin iron diaphragm in front of a magnet surrounded by a wire and within sound of the human voice, would create electrical vibrations, or undulations, of the same kind as those in the air, or when this diaphragm was acted upon by these electrical vibrations and undulations from a distance, would reproduce the originating sounds, including speech, with absolute fidelity.

Induction coils and magnets were familiar to everyone, and the German scientist, Reis, had transmitted musical sounds thirty-odd years before Bell made his discovery that a metal diaphragm could be acted upon by sound vibrations. Prior to that any attempts to reproduce speech were on the theory that the human vocal organs would have to be practically duplicated by complicated mechanical devices. The simplicity of the metal diaphragm, by comparison, becomes all the more significant.

There was but little delay in perfecting the Bell apparatus, and in the fall of 1876 and spring of 1877 telephone lines began to be erected, largely in the neighborhood of Boston. In 1878 the question of general intercommunication through central points in cities began to interest everyone, and no doubt many persons at various places realized the tremendous results to be obtained by the transmission of speech or intelligence without the intervention of the trained operator. At all events, efforts in this direction began to be general in the latter part of 1878.



ALEXANDER GRAHAM BELL,
Inventor of the Telephone.

The years 1879, '80, '81 and '82 were periods of strenuous development. Poles, wires, housetop fixtures sprang up like magic; poles became loaded, street crossings and housetop fixtures began to look as if giant spiders were at work.

Then (1883 and 1884) it was seen that those methods could not afford the necessary facilities, and to reduce space cables were introduced, first overhead, but here the increasing mass of wires and weight of cables made a resort to conduits and underground work a necessity, not only for the accommodation of the growing masses of wires, but in deference to the public demand that the wires be buried.

There seemed to be no limit so far as space was concerned to the use of underground wires and cables, but there were limits, due to electrical difficulties, to the distances over which telephonic transmission was possible under existing conditions.

The difficulties had to be overcome, or the use of the telephone would be limited to small areas, and intercommunication between towns impossible. The problem taxed the abilities of the best electrical engineers of the country, and various remedies were proposed, which, while they improved the conditions, still limited the area of communication.

Cross-talk, or what may be called an electrical echo, that is to say, the reflection of a vibrating or undulatory current in and through any adjoining wire or conductor, was partially removed by surrounding each wire with metal foil. This in turn contributed to another trouble called "retardation" or "self-induction." Twisting two wires together by breaking up the parallelism of straight wires, and properly placing these twisted wires or pairs in relation to each other seemed to afford a more or less effectual remedy for both of the above troubles, but it was found practically impossible to get mathematical precision in the adjustment and alignment of these twisted pairs.

In 1885 and 1886 hard drawn copper wire was produced, giving all the conductivity of copper, with the strength of iron, steel or phosphor-bronze. These advantages caused it to come into general use, and pole lines were rapidly established for greater distances, using double wires, or metallic circuits, and increasing the amount of copper in each wire, so that to-day, under such conditions, transmission is effective over distances from 1,500 to 2,000 miles.

The most important improvement, however, was the invention of the Pupin loading coil in 1900, now in extensive

use, which, when properly applied, would seem to make transmission effective to much greater distances, and to largely reduce the difficulties due to retardation, and also make it possible to transmit effectively through smaller wires to greater distances with less cost.

The handling of subscribers in thousands and tens of thousands in the large cities has called out the best work of the ablest engineers. The problem is not serious as long as we have but two or three thousand stations or subscribers, and comparatively simple switching devices will answer all purposes; when, however, subscribers are to be cared for by tens of thousands the problem becomes complex.

The improved common battery multiple switchboard aims to place each subscriber in any one office within reach of the answering operator This necessarily limits the number of wires in any one central office, which at the present time is about 10,000. It will be seen from this that the central offices in any large city must be multiplied, and this involves connecting trunk lines between all such offices, necessitating additional switching devices as well as operators. One of its great advantages has been the removal of the battery necessary for transmission from the subscribers' station to the central office.

AN INTERESTING SCENE IN THE NEW YORK OFFICE OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY ON THE OCCASION OF THE OPENING OF THE NEW YORK-CHICAGO LONG-DISTANCE LINE, OCTOBER 18, 1892.

Professor Alexander Graham Bell, is seated at the telephone desk talking to Mr. Hubbard at Chicago. Just behind Professor Bell, with his hand resting on the back of Professor Bell's chair, is Edward J. Hall, general manager, and immediately at the right of Mr. Hall is John Elbridge Hudson, then president of the company.

To maintain the greatest efficiency possible constant improvements are being made, and it frequently happens that a switchboard, sometimes costing tens, even hundreds, of thousands of dollars, must be superseded before it has suffered any appreciable wear and tear, in order to provide prompt and efficient service.

At present the common battery multiple board seems to be as nearly perfect as the present state of the art permits, and it is rapidly superseding all other forms of switchboard.

Our troubles from electric light currents of large quantity and great intensity began in 1886 and 1887. Then followed the trolley currents of still larger volume, adding not only to our electrical troubles within the cable, but also attacking and destroying the enclosing lead sheathing in the conduits. By cooperation with the electric light and trolley companies the damage done by stray currents of electricity in the earth has been reduced to a minimum, by providing sufficient conductors to carry the railway current back to its originating source.

To-day we are confronted by the partial electrification of the principal steam railway lines throughout the country. Their use of electricity involves currents of great volume and of an intensity far beyond anything we have heretofore had to contend with. It is believed, however, that we shall be able, with the cooperation of the electrical railway engineers, to adjust these troubles to the mutual advantage of both interests.

The almost incredible sensitiveness of the telephone, as well as the transmitter, and the amount or volume of current to operate it is so small that it is absolutely necessary to keep the wires or circuits entirely free from intruding or obtruding currents from any source. Telephone lines, traversing long distances as they now do, and crossing several states, encounter troubles not comparable with shorter lines. The weather conditions, for instance, may be bad on a portion of the route, or in one state, while good at either terminal. Electrical storms are not infrequent, and either or both originating in one section of the line may disturb its whole length.

The telephone sprang from the brain of the inventor a perfect instrument, which has undergone little or no change for nearly thirty years. The transmitter was more slowly developed, but for the last ten or fifteen years has undergone but trifling changes.

The difficulty of handling wires in large masses has been met and conquered by the cables and underground conduits, now so largely in use all over the country, and by the use of the Pupin loading coil, previously referred to. Underground trunk lines connecting the larger cities are now under way.

The difficulty of connecting any two subscribers within circumscribed areas in a few seconds, and for greater distances in a few minutes, have also been met largely by the common battery multiple switchboard already referred to. At the present time almost every hamlet, village, town and city has its telephone exchange, and trunk lines link them all together in

a system that covers the whole area of the United States and Canada.

What the future may have in store in the way of further difficulties no man may predict.

Who can estimate its value to commerce, to science, to social life? Business is transacted in seconds and minutes, instead of hours, days and weeks. New uses are being constantly applied, and the business of the country is adjusting itself to the advantages that the telephone brings, so that the ultimate development is still far in the future.

There seems to be no limit to the increasing use of telephones. The annual increase is greater each year, with no present indication of diminution. In no country in the world is the telephone development equal to ours. No metropolitan area, even with greater population, has such a telephone development as New York and its immediate vicinity.

Considering all the adverse conditions and liabilities, I think the telephone companies deserve great credit for the results now accomplished.

The Roentgen Ray and Its Uses.

By E. W. Caldwell, M.D.

ROENTGEN'S brilliant discovery, which only a little over ten years ago was the newest and most astonishing development of science, within an incredibly short time became a common every-day necessity like the telephone and the electric light, and yielded the centre of the stage to newer marvels like wireless telegraphy, the Bequerel rays and the radioactive elements of the Curies. We still know very little of the ultimate nature of the phenomenon which Roentgen so happily named X-ray because of the significance of the letter x in mathematical formulæ, but there are many reasons for believing that it is an ether disturbance, and therefore more or less closely related to other forms of radiant energy that are more familiar.

It may be a long time before the physicists demonstrate just what the X-ray is, but their experimental investigations of it and the radioactive elements of the Curies have led to interesting and important modifications of our conceptions of matter, and have shown that the atom is not indivisible, but is really a highly complex structure.

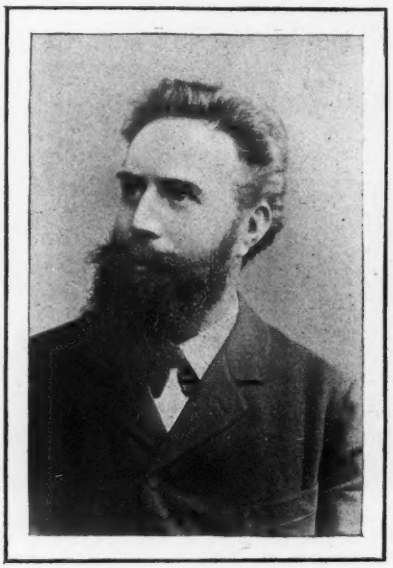
Although we have not found out what the X-ray is, much has been learned about how to produce and control it and apply it to practical uses.

Except in medicine and surgery it has few uses; but the fact that its practical application presents interesting electrical and engineering problems is sufficient excuse for presenting to the readers of the ELECTRICAL REVIEW some of the results that have been accomplished with it, as well as a brief statement of the appliances and methods concerned therein.

It was hoped that flaws in metallic castings and armor plates might be easily detected by the X-rays, but for various reasons, most important of which is the great obstruction offered to the rays by the heavy metals, this expectation has not been realized.

The fact that the diamond transmits the X-rays much more freely than any of its imitations suggests their use for distinguishing between genuine and spurious gems, but the diamond experts do not find it necessary to resort to such a cumbersome method.

Inspectors of customs have used the X-ray for examining travelers and their baggage for detecting dutiable articles concealed for the purpose of smuggling. The moral effect of these examinations is probably wholesome, and the concealment of metallic objects such as jewelry, in cushions, walking sticks and other articles that can not be opened without damage, is made more difficult. Many valuable articles, such as fine laces or unmounted diamonds, which transmit the rays freely, might, however, easily escape detection. Moreover, in view of the possibility of harmful effects from improper exposure to the X-rays, the indiscriminate subjection of travelers to such examinations is open to reasonable objection.



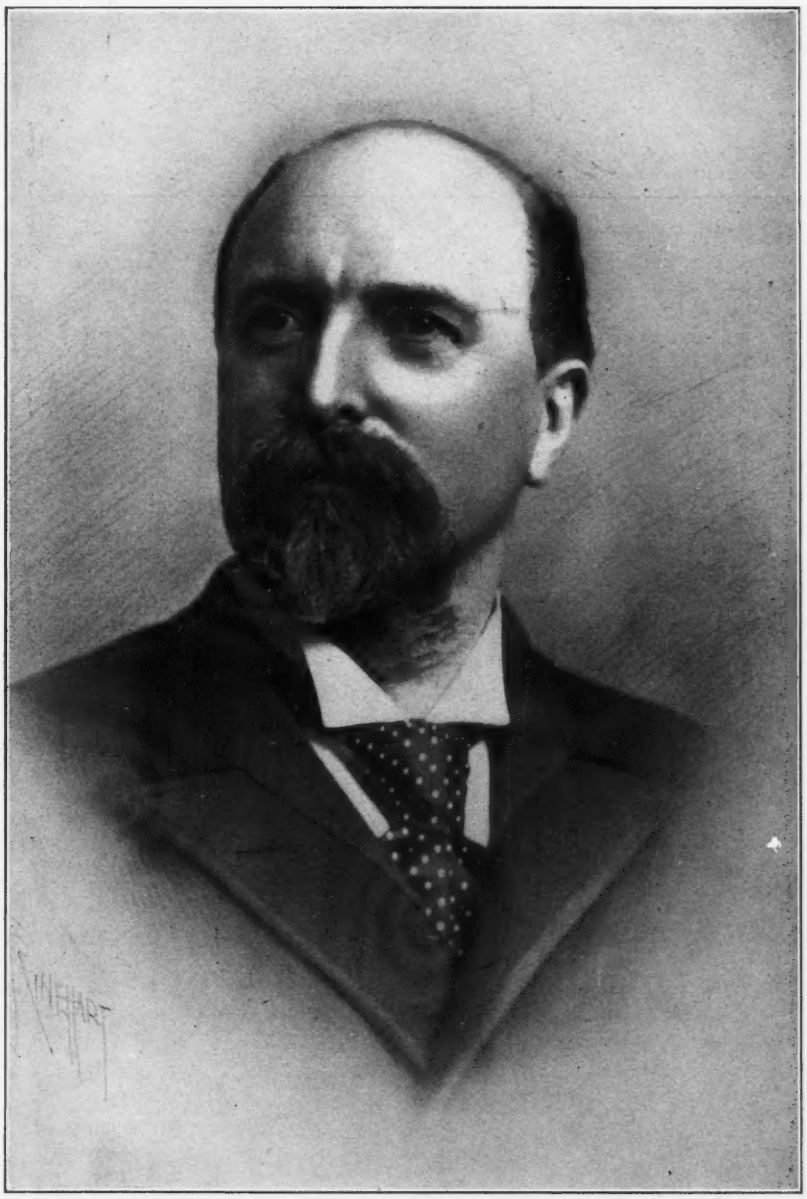
WILHELM KONRAD ROENTGEN,
Discoverer of the X-Ray.

Perhaps the most interesting commercial application of the rays is in detecting the presence of pearls, and similar formations used in jewelry, within shellfish. The method is much more certain and accurate than the usual one of opening the shells with hot water and dissecting the fish, and it may be performed without sacrificing the life of a pearl-bearing mussel or destroying its value as an article of food.

In medicine and surgery the uses of the X-ray are so important and varied that it has become quite indispensable. These uses may be classified in two distinct, but perhaps equally important, groups; *i. e.*, diagnosis and therapeutics.

In the diagnosis of injuries and diseases of the bones the X-ray scored its first important success and it now gives us the most accurate information obtainable in such conditions. By detecting and accurately localizing bullets, needles and other foreign objects in the body, the X-ray greatly simplifies the surgical operation for their removal. It may be relied upon to answer the important question whether the baby has swallowed a safety pin or a coin, and if such an improper and indelicate article of diet had lodged in the œsophagus, as it commonly does, the fluoroscope greatly facilitates its removal.

With the improvement that has been made in appliances and technique the field of Roentgen diagnosis has been steadily enlarging. For the detection and localization of stones in the urinary tract the X-ray is more accurate and reliable than any other single agent. Much information concerning the heart and lungs may be obtained in the skiagraph or by direct examination with the fluorescent screen. The stomach and intestines, which ordinarily give no X-ray shadow, are brought into the field of Roentgen diagnosis by inflating them with air or gas, which transmits the rays more readily than the surrounding tissues, or by



COLONEL ROBERT C. CLOWRY

President of The Western Union Telegraph Company

A pioneer telegrapher, who, from the ranks, has risen to the command of the greatest telegraph system in the world

feeding a meal of mashed potato flavored with bismuth subnitrate, which fills the cavities with a material offering sufficient obstruction to the rays to produce a distinct shadow. Dentists employ the X-ray for examining the roots of teeth, for detecting teeth that have not erupted and for showing the presence of pieces of dental drills that have been broken off and lost. For such purposes skiagraphs are made on small pieces of sensitive film enclosed in light and watertight coverings and placed in the mouth.

The skiagraph is used for all difficult X-ray examinations, because the photographic plate gives infinitely more detail than can be obtained on the fluorescent screen. The fluoroscope, however, has the great advantage of giving immediate results and of making it possible to observe certain movements, such as the pulsations of the heart and the excursions of the diaphragm in breathing.

Unfortunately the X-ray can not ordinarily be reflected or refracted, and therefore gives only shadow pictures. This difficulty may be partly compensated for by making stereographic projections and viewing them with a reflecting stereoscope, which will often supply abundant perspective in the skiagraphs.

As a therapeutic agent the X-ray has not fulfilled the extravagant claims that were made for it by the early enthusiasts or by those physicians who do not hesitate to attract attention to themselves and their alleged cures by means of illustrated articles in the Sunday newspapers. It has, however, been extremely useful in the treatment of many diseases which affect the skin and certain glandular tissues. No deep-seated cancers have been cured by it, although in many cases the pain has been lessened and the progress of the disease seems to have been retarded. It is often used after surgical removal of cancerous growths for the purpose of preventing or delaying recurrence of the disease that may result from any cancer cells that have escaped the surgeon's knife.

The so-called X-ray burn is a peculiar disturbance of the life and growth of the tissue cells. It looks at first like a sunburn, but may become more severe and persist for months or years. No sensation of heat is felt during the exposure, and the effect appears usually not earlier than five nor later than twenty days afterward. The use of protective shields, gloves, aprons, etc., has practically eliminated this danger to both operator and patient. Ray filters of leather or thin aluminum, which absorb the rays of low penetration, are interposed between the Crookes tube and the skin for the purpose of cutting off those useless rays, which would otherwise be absorbed by the skin.

The degree of penetration of the rays from a Crookes tube increases with the potential difference at its terminals. This is measured roughly by the length of the spark that may be obtained in a gap bridging the lead wires of the tube, and in practical work is represented by sparking distances of two to five inches.

Owing to the necessity of using unidirectional discharges for exciting the Crookes tubes, high frequency apparatus and alternating-current transformers have been comparatively little used for this purpose, although several ingenious methods of suppressing and rectifying the inverse current wave have been developed. The Holtz and Wimshurst influence machines are extensively used by physicians, but for difficult X-ray examinations induction coils with electrolytic or mercury jet interrupters are giving the most satisfactory results.

The relatively low potential inverse current induced at the closure of the primary circuit of the induction coil is eliminated by series spark-gaps or vacuum tube rectifiers. The pulsating currents thus obtained may be measured roughly by a milliampere meter in series with the Crookes tube. Electrostatic disturbances of the meter are avoided by inserting it at the neutral point of the secondary winding or by a connection between one of the meter terminals and its metallic casing. With a very powerful excitation of the Crookes tube such a meter will indicate as much as ten to twenty milliamperes when the apparatus is absorbing three to ten kilowatts from the lighting circuit. Under such conditions skiagraphs of the thick parts of the body may be made with exposures of one to twenty seconds. This is from five to twenty times faster than the best work of the influence machines. The influence machines are very bulky for the amount of energy delivered and they are susceptible to changes in the humidity of the air. They are, however, safer in unskilled hands than the induction coils, and for simple fluoroscopic examinations they are very satisfactory.

The importance of short exposures in skiagraphic work is due to the fact that movements of the subject must be prevented, and in many cases it is essential that respiration be suspended during the exposure.

The improvement that has been made in induction coils, interrupters and other X-ray appliances is shown by the fact that the exposures in skiagraphic work are forty to sixty times faster than they were a few years ago.

In the early attempts to obtain more powerful excitation of the Crookes tubes some extremely bad induction coil design was shown. German coils wound and insulated for sparks one metre long were imitated here and elsewhere. Present practice tends toward the use of much less expensive and more efficient coils designed for large ouput at a potential difference represented by spark lengths of ten or twelve inches. Such potential differences are enough in excess of those required by the Crookes tubes to provide for the rectifying spark-gaps or valves tubes.

The use of powerful induction coils and electrolytic interrupters has made necessary great increase in the size and strength of the Crookes tubes in order that they may withstand the large amounts of energy delivered to them even for a few seconds. The tubes commonly used for rapid skiagraphic work are eighteen to twenty inches long with bulbs seven or eight inches in diameter. The targets are made of platinum-faced masses of copper or some alloy weighing one to three ounces. Even this large thermal capacity does not prevent fusing the target at the focus point of the cathode stream.

Hollow platinum targets cooled with water are in common use and are very effective, but the liquid is somewhat inconvenient. These tubes are quite expensive and their useful life is much shortened by the strain of powerful discharges that are necessary for short exposures.

There is now no satisfactory practical method of measuring either the penetrating quality, the photo-chemical action or the physiological effect of the X-ray, and this is perhaps the greatest need of Roentgen workers at present

The physiological effect of the ray probably bears a close relation to the photo-chemical action, and this has been measured roughly by the change in color produced in certain chemical compounds which are incorporated in standard testing wafers. Such a wafer may be placed on the skin during a therapeutic exposure and afterward compared with a standard color scale.

The property of the rays of ionizing gases has been employed for purposes of measurement. In this work an electrom-

eter like the one used by the Curies for standardizing radioactive substances has been employed.

Still another method of measurement is based on the change in resistance of a selenium cell illuminated by the fluorescence excited by the rays in calcium tungstate or barium-platinum-cyanide crystals.

Measurements of the current supplied to the tube and the difference of potential at its terminals are very useful. A simple tinfoil electroscope is sometimes used for indicating roughly the potential at the terminal of the tube.

Because of the wide variation in the penetrating quality of the rays and the consequent variation in the amount of absorption by the body tissues, the photographic plate, and the measuring device itself, all measurements are useless unless the quality of the rays is taken into account.

Penetration gauges consisting of a fluorescent screen having behind it metallic plates of different standard thicknesses through which the rays pass to the screen, are useful, but far from accurate.

What developments the future will bring to the X-ray can not be foretold. There is need for shorter exposures in skiagraphic work, less complicated and more convenient apparatus and better means for controlling the rays both in diagnostic and therapeutic application.

The best engineering talent has been engaged in work of greater commercial importance than the development of X-ray apparatus, and there remain to be solved many interesting and difficult problems in this important although unremunerative field.

Electric Lighting by Incandescence.

By William J. Hammer.

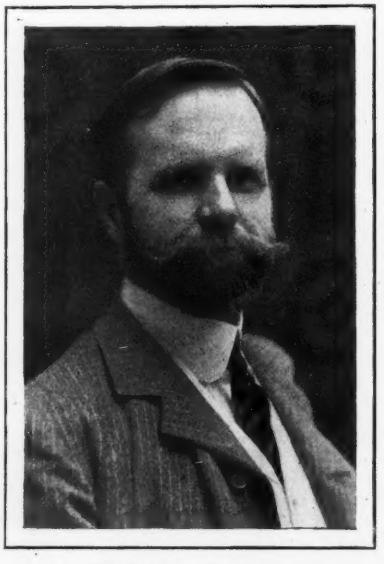
"There on the tremulous bridge that from beneath
Had seemed a gossamer FILAMENT *up in air."*—TENNYSON.

THE raising to incandescence of badly conducting substances by means of a current of electricity has occupied the attention of a host of investigators since the time of Sir Humphrey Davy, who, in 1810, by means of his celebrated battery of 2,000 cells and his strips of charcoal, laid the foundation not only for arc lighting, but for incandescent lighting as well. For, after describing his experiments with the arc light, which are so well known, he says:

"And a platinum wire one-thirtieth of an inch in thickness and eighteen inches long placed in circuit between bars of copper instantly became red hot, then white hot and the brilliancy of the light was insupportable to the eye."

Subsequently Grove, de Moleyns, de Changy, Farmer, Starr, Draper, Watson, de Lodyguine, Gardiner and Blossom, and later Edison, Maxim, Sawyer, Lontin, Lane, Fox and others employed the incandescence of platinum, by an electric current, in the production of light; and the French chemist, Tesse du Motay, employed platinum sheets and foil made incandescent in the hydrogen flame. Nearly all the early investigators produced the incandescence in the open air. Certain of them employed a Torricellian vacuum, and later Edison and others employed by Sprengel, Geissler, and other pumps, employing also dynamos in place of batteries formerly used for furnishing currents.

None of this early work possessed even a semblance of a commercial solution of the problem of lighting by incandescence; but Edison subsequently found that by alternately heating and cooling the platinum and driving out the occluded gases that he could so change its characteristics as to practically produce a new material, the originally soft and pliable platinum becoming as rigid as a steel piano wire, homogeneous as glass and with a brilliant, silverlike surface. It could not then be annealed by any known method nor touched by a file, and platinum spirals which he made with a radiating surface of 3.1-16 inches, which would normally melt at a temperature at which they gave but four candles of light, he found, after treatment, could be burned at from thirty to thirty-five candle-power. Petrie first suggested the use of iridium as a filament, and subsequently Staite, Starr and le Molt suggested its use alone or alloyed with platinum, and subsequently Edison, Sawyer, Poland and others employed it; and Staite used alloys of iridium with platinum and copper. Farmer also experimented with other metals, including palladium, aluminum, nickel, cobalt, iron and their alloys. Other investigators worked on various metals and alloys, Edison trying boron, ruthenium, chromium, etc.



WILLIAM J. HAMMER.

The foregoing will serve to show that a large amount of active work was done in the early days upon metallic filament lamps, and will serve to emphasize the statement made by the writer at a recent meeting of the American Institute of Electrical Engineers, in which he spoke of the pendulum of time swinging from the metal filament lamp of long ago to the carbon filament lamp which has almost exclusively occupied the field for more than a quarter of a century past; and of the pendulum now swinging back again to the metal filament lamp. In justice to the earlier investigators it must be stated that many of them suggested or employed the incandescence of carbon, among these being Starr, Greener and Staite, de Lodyguine, Kosloff, Farmer, Jacquelain, Fontaine, Konn, Adams and Sawyer; and even as far back as October 26, 1836, Professor Loyet, writing in the *Courier Belge,* says: "We would speak of the incandescence of charcoal produced in vacuum by means of the Voltaic pile." And de Changy speaks of Professor Jobard, of Brussels, suggesting, in 1838, in the *Courier Liberal,* the idea "that a small carbon employed as a conductor of a current in a vacuum would give an electric lamp with an intense fixed and durable light." Nothing, however, came of the early work in this line, and in fact the advent of the dynamo was essential to commercial success. Starr, however,

showed to Faraday and many others a candelabrum of twenty-six of his lamps supplied from batteries, these lamps representing the twenty-six states then in the Union. This occurred while Starr was in London shortly before his death in 1847. It is interesting to note that the first patent granted in the United States for an incandescent electric lamp was that of S. Gardiner, Jr., and L. Blossom, United States patent 20,706, of June 29, 1858. It was for an electric signal light and consisted of a single platinum spiral. This patent was, however, antedated by the British patent of another American, J. W. Starr, of Cincinnati, Ohio, a protégé of the philanthropist Peabody. Starr's patent was filed through his agent, King, in whose name it was granted. (See British patent 10,919, of November 4, 1845.) The first American patent was also slightly antedated by the Belgian patent of de Changy, of April 8, 1858. Starr refers to the use of a thin, transparent leaf of platinum and also speaks of the use of carbon and of employing, in connection therewith, a Torricellian vacuum, while de Changy used a platinum wire and spiral, making no reference to the use of an exhausted chamber.

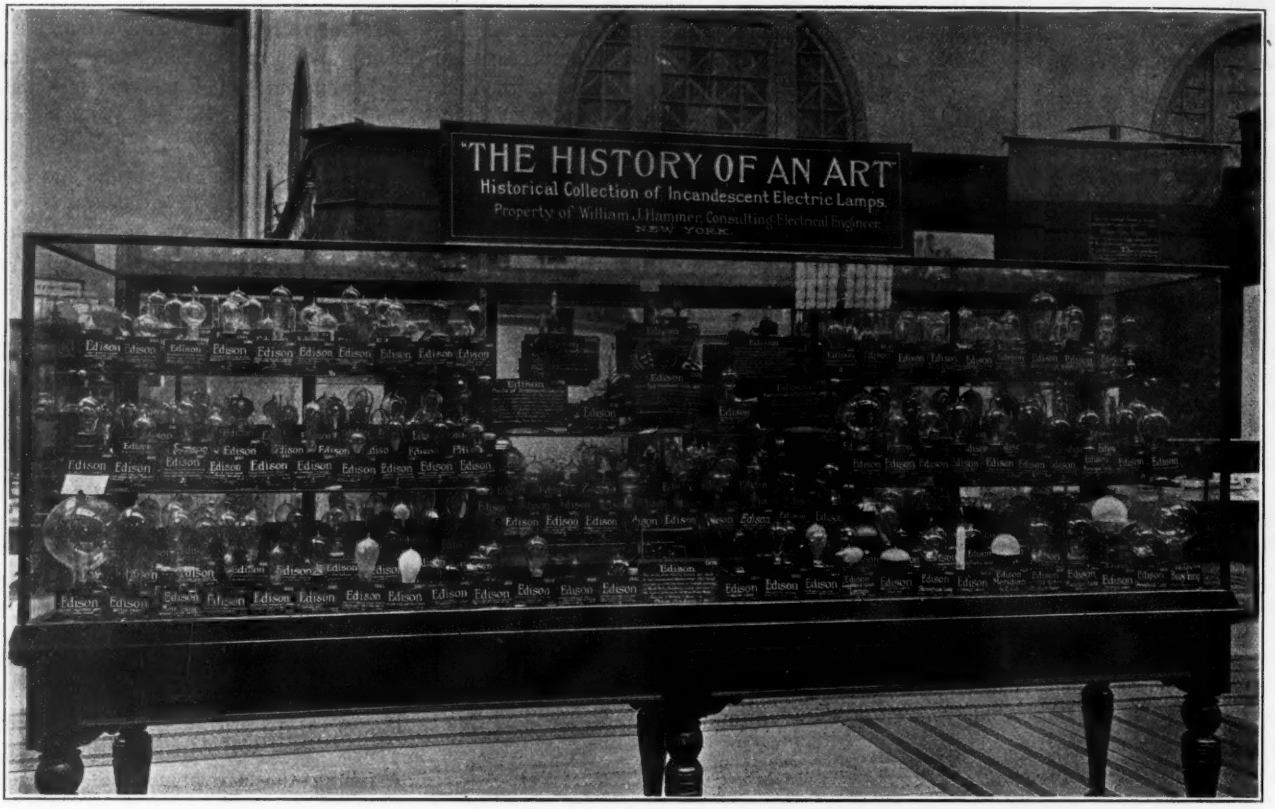
The tribunals of the world have adjudicated Thomas A. Edison to be the inventor of the commercial incandescent electric lamp; but the able work of those already referred to and that of Swan, Lane Fox, Maxim, Weston, Sawyer and Man, Cruto, Gatehouse, Swinburne, Girard, Diehl, Siemens interests, Schaefer, Opperman, Crookes, Boehm, Bernstein, Stanley, Thompson, de Khotinsky, Seel, Akester, Alexander, Richter, Schuyler, British Electric Company, Müller, Kurtzgen and other early workers should not be forgotten.

Doubtless the future will give full credit to the important work of Edison's predecessors and his contemporaries in the art of incandescent electric lighting. There is neither time nor space on this occasion to do even scant justice to these workers; but the writer has always been most anxious to do this, and as an evidence thereof he respectfully calls attention to the illustrations which he has been asked to incorporate in this article, which show his historical collection of incandescent electric lamps and which has been aptly termed "The History of an Art." The writer has spent some twenty-eight years upon this collection, and while the illustration represents it as it appeared at the St. Louis Exposition of 1904, where it received the "Grand Prize," it to-day stands practically complete and up-to-date and embraces considerably over a thousand lamps, each lamp marking an important step in the art, and in nearly all cases they are the first, or among the first, of the lamps made by the various inventors.

The writer wishes to call attention to a circumstance which seems to him little less than extraordinary. It is now twenty-eight years since Edison perfected his carbon filament lamp, "the first commercial incandescent lamp," and it stands to-day as it did in 1879 without a single basic feature eliminated nor an absolutely essential feature added. The Edison lamp embraced then, as it does to-day, the following features: An attenuated high-resistance filament of carbon hermetically sealed in an all-glass receptacle, with platinum leading wires passing through the glass, and the exhaustion of such receptacle upon a vacuum pump to a high degree prior to its being sealed hermetically. (See Edison United States patent 223,898 of January 27, 1880, filed November 4, 1879.) In making the above statements the writer does not for one moment wish to disparage the able work done by others in this field, especially that of the technical staff of the various lamp companies, in the simplifying and perfecting of the manufacturing processes, such as the making, carbonizing and treating of the filaments, exhausting the globe, anchoring the filament, and developing automatic machinery by means of which the cost of construction has been enormously decreased and the efficiency of the lamp increased from the 4.4 to five watts per candle of the early Edison lamp to the 3.1 watts per candle of the standard type of Edison lamp of to-day, and the further efficiency attained by the graphitized filament lamp of 2.5 watts per candle. But, making all due allowances, I ask where can an invention in any art be pointed to which has stood such a test of time as has the Edison lamp.

The tendency of all great inventions is not to pull down, but to build up. There are many who will remember the panic caused in the gas lighting industry by the appearance of the Edison platinum lamps of 1878 and the effect of his "paper horseshoe" carbon filament lamp of 1879. Many feared that gas as an illuminant was doomed; yet to-day far more gas is burned than ever; but to-day we are practically forced to admit that the wonderful results obtained by the new metallic filament and other new filament lamps coming to the front so rapidly will sound the knell of the carbon filament lamp. The new metal filament lamps certainly possess remarkable commercial advantages in their extraordinary efficiency, which may be conservatively stated to be one watt per candle and less, their long life, non-blackening of the globe, the coolness of the globe, the increase of resistivity with temperature, their high melting points, the doing away with the "smashing point" of the carbon lamp occurring at a fall in the initial candlepower of twenty per cent, the quality and uniform color of the light at various voltages, their ability to operate equally well, as a rule, upon direct and alternating currents, their ability to stand considerable variations in potential, the less emissivity of bright metal as compared with carbon, the ability to re-weld the broken filament and the utilization of filaments of broken lamps.

A leading authority in the gas industry in this country recently remarked to the writer, "Were it not for the Welsbach mantle, we should be down and out to-day," and a prominent officer of one of the largest gas concerns in America said to the writer, but a few days ago, that he was watching the development of the new metal filament lamps with the greatest concern, and one sees every indication that within the next few years greater advances will be made in the procuring of economical and satisfactory illuminants than has been made during the past quarter of a century and over. The late Professor Rowland once remarked that "a Steinway grand piano was a comparatively simple piece of mechanism compared with an iron atom." Doubtless comparatively little is known to-day regarding the carbon atom and there is sore need at the present time of an Edison or a von Welsbach to save the carbon filament lamp, and I might add certain other illuminants as well. Leaving out of consideration for the present the gaslight and the arc light, what for instance is to become of the tantalum lamp which Minerva-like sprang forth "full fledged" upon the world so recently. Can it hold its own with its efficiency of two watts per candle, even admitting that its makers have found ways to operate it on alternating circuits and lessen its cost of manufacture? What of the future of the Nernst lamp, even with an efficiency of half that of the carbon lamp, say 1.5 to 2 watts per candle, and the production of the new replacement piece at a cost of but twenty cents? Can it hold its own with its high initial cost, slow starting up, resistance of heater and ballast, blackening of reflecting surfaces and globe, depreciation


"THE HISTORY OF AN ART"
Historical Collection of Incandescent Electric Lamps.
Property of William J. Hammer, Consulting Electrical Engineer.
NEW YORK.

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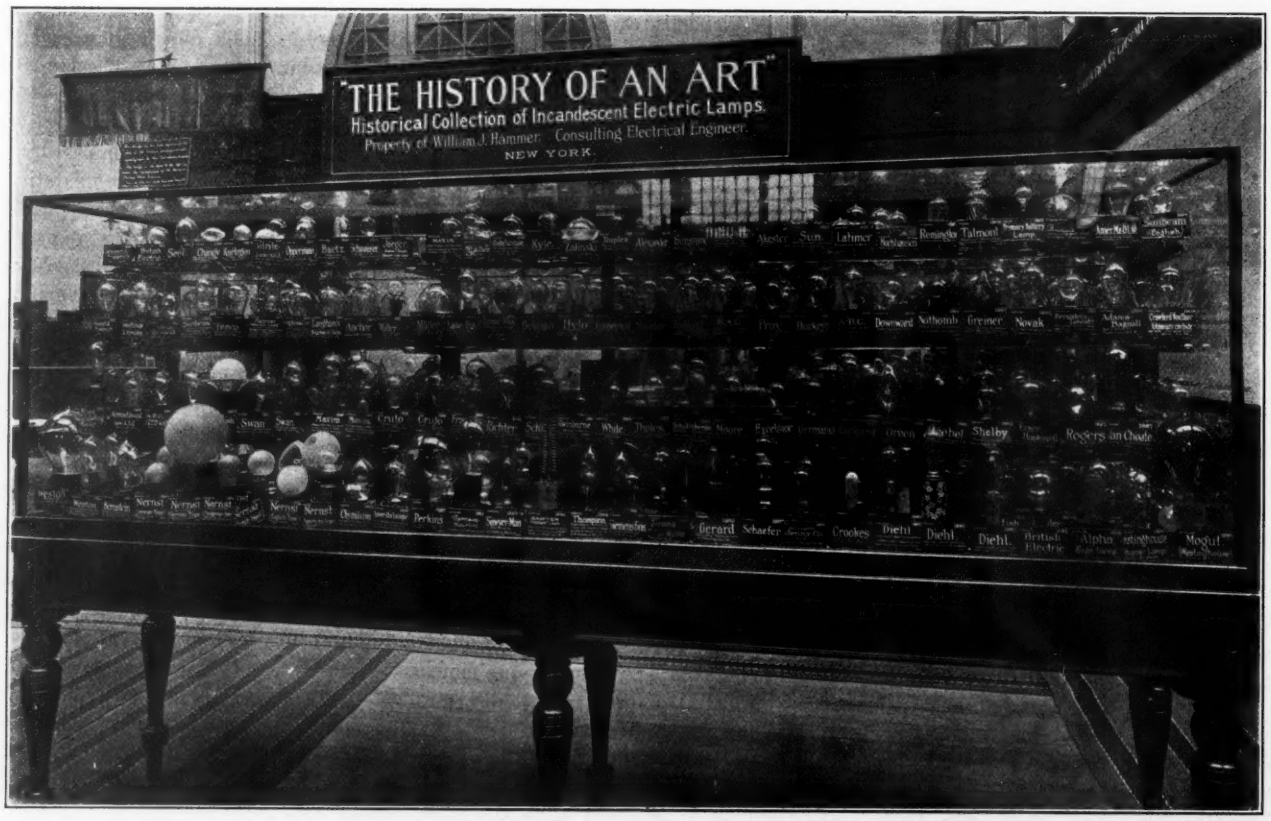
THE HAMMER COLLECTION OF INCANDESCENT LAMPS AS EXHIBITED AT THE ST. LOUIS EXPOSITION, SHOWING EXCLUSIVELY THE WORK OF EDISON.


"THE HISTORY OF AN ART"
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THE HAMMER COLLECTION OF INCANDESCENT LAMPS AS EXHIBITED AT THE ST. LOUIS EXPOSITION, SHOWING THE WORK OF THE CONTEMPORARIES OF EDISON.

in candle-power, its complexity, its sensitiveness to variations of potential and to the alternating current? What of the osmium lamp of von Welsbach, with its efficiency of 1.5 watts per candle? Can it remain in the game with its high initial cost, low resistivity, frailty, softening of the filament when heated, necessitating burning it in a pendant position, extreme brittleness when cold, and with the limited supply of osmium? The company, after practically cornering the market, is endeavoring strenuously to locate new sources, which sources, now as heretofore, are limited to the by-products of the refinements of platinum and a trifle from osmiridium. It would seem that certain of the leading electrical interests here and abroad have been lulled into a sense of security by reason, not only of the satisfactory character of the carbon incandescent lamp, *per se*, but also of the very satisfactory condition of the lamp business from a financial standpoint. This does not apply with such force to foreigners, as conditions abroad are somewhat different, due to the practice of charging for lamps, to competition, cost of labor and other factors. Doubtless the development of the electric furnace and the securing of facilities for producing temperatures heretofore unknown, the development of electrolytic and chemical processes and the pyrometer have added greatly to the knowledge and experience of physicists, metallurgists, chemists and others, of the properties of rare metals, metallic oxides, rare earths, etc. While great credit is due to the foreigners, especially to the Austrians and Germans for their work on the gas mantle, the flaming arc, the Nernst lamp, tantalum, osmium, tungsten, zirconium and other metallic filament and composite filament lamps, it must be remembered, in justice to our own country, that we also have men who have done able and pioneer work upon the new metallic filament, composite filament and glower lamps. In speaking of Nernst, von Welsbach, von Bolton, Langhans, Kuzel, Just and Hanaman, Crawford-Voelker, Zernig, and Hollefreund in Europe, we must couple the names of de Lodyguine, Heany, Parker and Clark with them, and not overlook the work of Edison, Bernstein, Shapleigh, Wurts, Potter, Hanks, Whitney, Howell, Cazin, Thowless and others; and it is to be observed that the big lamp companies, no longer "asleep at the switch," to-day have a veritable host of investigators at work upon metallic filaments. Carbon filaments coated with boron, ruthenium, niobium, tungsten, silver, chromium, manganese, zircon, silicon, etc., and these substances also in a comminuted state with various forms of carbon, etc., have been much experimented upon. The work of de Lodyguine dates back to the early seventies, when, in Russia, he did important pioneer work upon platinum and carbon which brought him one of the Grand Prizes of the St. Petersburg Academy of Science, and subsequently in this country from 1892 to 1894 he was engaged in experimenting upon filaments formed from highly refractory metals whose gaseous chlorine compounds, upon mixture with hydrogen, deposited themselves in metallic form upon a platinum or carbon base or temporary support, which he terms in his United States patent, 575,002 of January 12, 1897, a "fillet," which, quoting from his patent, he stated "formed no part of the illuminant itself and preferably an insignificant dimensional relation to the completed illuminant. Upon this 'fillet' then I deposit the illuminant proper, which contains the 'fillet' as an accident of manufacture and not as a portion of itself." He refers to the employment of molybdenum, tungsten, rhodium, iridium, rutheneum, osmium and chromium and the use of the chlorides, chlorates, or any other gaseous chlorine compounds of these metals. And he describes his process when the oxychlorides are used in which, owing to their greater specific gravity, they are introduced at the top of the vessel containing the "fillet" and as they descend the lighter hydrogen gas entering from below decomposes the oxychloride and deposits it in pure metallic form upon the "fillet." In this patent he refers explicitly to the use of chromium, and in his second United States patent, 575,668, of January 19, 1897, he claims specifically the use of molybdenum as an incandescing body. De Lodyguine recently informed the writer that, while he had succeeded in making lamps which lasted several hundred hours, they would blacken so rapidly as to almost at once destroy their usefulness as illuminants, and this and his inability to secure a sufficiently attenuated "fillet" together combined to prevent him from producing a commercial incandescent electric lamp. However, this work of de Lodyguine is of importance by reason of the work along the same line being done by Just and Hanaman abroad and the work of Parker and Clark in this country, who practically used the "fillet" of de Lodyguine. Just and Hanaman in their wolfram (tungsten) lamp used a fine carbon filament in the presence of oxyhalogen compounds in the presence of hydrogen gas, they claiming that pure metallic tungsten is deposited upon the filament. Parker and Clark, of New York, also use a fine filament of carbon in their very interesting Helion lamp. In this lamp silicon is reduced from a gaseous form in combination with carbonaceous gases on the surface of a high-resistance carbon core. The inventors claim it operates at the high temperature (2,300° cent.) without the carbon and silicon uniting to form carborundum, as would be supposed; that the silicon shows no tendency to become molten or fluid at the temperatures attained; that it starts with a negative temperature coefficient less than carbon, and at about red heat changes distinctly to positive and remains positive as high as the temperature is carried; that there is practically no disintegration or blackening of the globe; that the permanency of the filament is probably due to the low vapor density of the silicon, and they claim results of from 600 to 1,000 hours and an efficiency of one watt per candle or less. It would be interesting, were there time and space, to refer to the various methods employed in the manufacture of metallic filaments which might be termed the electrolytic substitution, colloidal, conversion, drawn ductile wire, chemical, composite filament and trituration or mechanical processes; and also to the use of binders; systems of mounting, and methods of treatment of the filament, out of contact with oxydizing agents, etc. But this is too big a subject in itself.

Of the work of John Allen Heany, of York, Pa., the writer believes much will be heard, as Mr. Heany has been engaged in this field of rare metals, metallic oxides, etc.—at least so I am credibly informed—during the past twelve years, and he made metallic filament lamps over seven years ago. He has been unwilling to tell of his work, but the writer has been given an opportunity of investigating his work and his records during a considerable period of time. And he feels confident as a result thereof that it will ultimately be found that Heany antedates much of the work done by the foreigners in this field, of which so much has been said in the press. Mr. Heany claims life tests of over 1,000 hours at less than one watt per candle. His tungsten tested by Messrs. Waidner and Burgess, of the Bureau of Standards at Washington, showed a temperature of 3,200° cent. without blackening of the globe. It is interesting to note, in this connection, that on last Christmas day Mr. Heany received the first tungsten

patent granted in America (United States patent, 839,585, of December 25, 1906, original application filed December 29, 1904). In this patent he specifies a filament for incandescent lamps composed exclusively of a metallic alloy of tungsten and titanium in a dense shining coherent state, and homogeneous throughout, and he describes the method employed by him. On January 29, 1907, Heany received a second patent for a filament for incandescent lamps consisting exclusively of metallic titanium (United States patent, 842,546, of January 29, 1907, filed December 29, 1904). Other tungsten lamps than those already mentioned are those of Kuzel, and the Osmin lamp, of Vienna, and the Osram, and the Zernig "Z" or Hollefreund lamp, of Berlin, and the Canello, of Paris. Recently the General Electric Company, the Westinghouse Electric and Manufacturing Company, and other manufacturers in this country have been actively working upon the tungsten lamp. The writer is of the opinion that there is a large field and a large future for the vacuum tube and the mercury arc lamps, especially the former, owing to its superior spectrum and ability to vary the same, the simplicity of manufacture and operation, infinite length under proper conditions, etc. The Moore tube of this type is made with a yellow, pink or white color, in three types of tube, with relative efficiencies of one and one-half, two, and two and one-half watts per candle. The Cooper Hewitt light possesses advantages of its own, especially its high candle-power and in its use for outdoor illumination and in its efficiency of .3 to .6 of a watt per candle. In conclusion the writer might add that he is a firm believer in the ultimate solution of the problem of securing a satisfactory and efficient illuminant by means of the stimulation of phosphorescent and fluorescent substances in various ways, thus producing a "cold light," a light without flame and without heat; and he has for some time been working in this field, which he believes is one full of promise. Professors Langley and Very have shown that the light of the Pyrophorous Noctilucus, or Brazilian beetle, has the highest efficiency of any known light. Professor Dewar is recently quoted as stating that the incandescent lamp gives an efficiency of one and one-half to two per cent and never over three per cent, whereas certain phosphorescent creatures and substances give a light with an efficiency of ninety-nine per cent. Certainly we must soon stop producing long and useless heat waves, and also, as far as possible, all radiations outside the visible spectrum, in the utilization of our illuminating agents, and expend the energy in the production of luminous waves or vibrations.

Some Electric Traction Notes.

THE early history of electric traction has been well written in quite recent times, and in this article only a summary of the work of the early investigators and developers of this department of electrical industry will be ventured. Two contributions to recent literature upon this subject are of particular interest because of their authenticity. One of these was published in the Historical Number of the ELECTRICAL REVIEW, January 12, 1901; the other was published in 1905, in the July and August numbers of the *Century Magazine*, the author being Frank J. Sprague.

Thomas Davenport, a blacksmith of Brandon, Vt., is credited with having first suggested the electric railway, although an Italian priest, Abbe Salvatore Del Negro, professor of natural philosophy at the University of Padua, is reputed to have designed an electric toy traction machine of the reciprocating type in 1830. Davenport ran a toy motor mounted on wheels on a small circular railway in 1834, exhibiting this a year later at Springfield and Boston, Mass.

Robert Davidson, of Aberdeen, Scotland, some time in 1838 constructed a locomotive equipped with a motor. This engine was demonstrated on the Edinburgh-Glasgow Railway, Scotland.

Henry Pinkus, an Englishman, indicated the use of rails for carrying electric current in a patent issued in 1840. A like patent was issued in America to Lilley and Colton in 1847. Professor Moses G. Farmer, in the same year, operated an experimental car carrying two passengers at Dover, N. H., and three years later Professor C. G. Page, of the Smithsonian Institution, helped by a special grant from Congress, constructed several forms of motors. One of these, driven by a battery of 100 Grove cells, was tried April 29, 1851, on a road between Washington and Bladensburg.

It was in 1851 that Thomas Hall, an instrument maker of Boston, operated a small model driven by current taken through the rails from a stationary battery. Hall also exhibited another model called the Volta at the Mechanics' Fair in Boston, 1860.

During the period intervening between the exhibition of the Hall models a patent had been issued in 1855 to an Englishman named Swear, and patents were issued in France and Austria in the same year to Major Alexander Bessolo, of the Italian army. The latter patents exhibited the third rail, which was indicated at that time, however, for telegraph purposes only.

For some twenty years, then, almost nothing had been done in the direction of developing the electric railway, the inventors of the earlier day all having reached the conclusion that electric operation was feasible, but prohibitive because of the costly nature of the batteries. The development of the Pacinotti dynamo in 1864, and, three years later, the work of Wheatstone in England and Werner Siemens in Germany, brought out the principle of the self-exciting dynamo. Gramme's discovery, about 1873, of the reversibility of the dynamo, and the work of Fontaine, Breguet and Von Hefner Altneck, not forgetting our own Professor Henry Rowland, was a grand advance in making possible electrically operated traction systems. In 1875 George F. Greene, of Kalamazoo, Mich., constructed a model railway, in many points similar to Farmer's model. He used the track rails for conductors. In 1879 he built a comparatively large car carrying two passengers, and realized the necessity of a dynamo for furnishing current. He applied for patents in August, 1879, but, being without funds, his patents languished in the Patent Office for twelve years, and were not finally granted until 1891, Greene in the meantime being unable to develop his apparatus.

In the summer of 1879 Siemens & Halske exhibited an electric locomotive and one car at the Berlin International Exposition.

The next year, 1880, witnessed an important advance in electric traction, and marks the advent of a new type of inventor and organizer; and from this period on, although there was not accomplished anything remarkable, as measured by present-day ideas, a wonderful amount of ingenuity, perseverance and indomitable courage was displayed.

In May, 1879, Stephen Dudley Field filed a caveat covering an experimental

electric railroad, antedating by a very brief period the announcement of similar ideas from Thomas A. Edison.

In 1881 Siemens & Halske opened a third-rail line in Berlin. This was the first commercial electric railway in the world. During the summer of the same year Siemens & Halske changed over the Charlottenburg and Spandau horse-car line, equipping it with an overhead electric system.

Experiments were made with an accumulator car on a one-mile track by Duchesne-Fourmet at Breuil-en-Ange, France. In the summer of the next year an accumulator car was put on the Vincennes tramway line in Paris.

In the summer of 1883 Dr. Werner Siemens equipped an electric line to the Giants' Causeway, near Portrush, Ireland, the road being opened on November 5.

In the same year the Field and Edison interests were consolidated in the formation of the Electric Railway Company of the United States, the company laying down an experimental railway for the Chicago Railway Exposition in June of that year.

C. J. Van Depoele exhibited an overhead line in the autumn of 1883, and about the same time Leo Daft equipped a short length of road between Saratoga Springs and Mount McGregor, N. Y. The next summer Mr. Daft built a short line on the Iron Pier at Coney Island, N. Y. At the same time E. H. Bentley and Walter Knight constructed in Cleveland, Ohio, an underground conduit road about two miles long. This system ran successfully for more than a year, when Bentley and Knight went to Providence, R. I., to take up larger work. A conduit line was also constructed across New York city, through Fulton street, and in Boylston street, Boston, about the same time.

In the autumn of 1884 J. C. Henry constructed an overhead line in Kansas City, Mo., using Van Depoele motors on the cars.

In the spring of 1885 the Baltimore Union Passenger Railway Company contracted with Leo Daft for the equipment of a suburban branch of its system, running about three miles out of the city to the village of Hampton. This was a third-rail electric line. About the same time Van Depoele constructed a short line at Toronto, Ontario, using an overhead system.

Frank J. Sprague, in December, 1885, presented a paper to the American Institute of Electrical Engineers discussing the electrical equipment of the New York elevated lines, beginning his experimental work on the Thirty-fourth street branch of the elevated system in the early part of the next year.

It was in the spring of 1887, however, that the great advance was made in practical electric railroading. The Union Passenger Railway Company, of Richmond, Va., entered into a contract with Mr. Sprague for the equipment of its new lines, then building. Work was begun early in 1888 and carried to a most successful completion by dint of a monumental amount of labor and perseverance.

On January 1, 1888, there were thirteen electric railways in the United States and Canada. There were ninety-five motor cars, operating over forty-eight miles of track. Of these roads, six were on the Van Depoele system, three on the Daft system and one each on the Fisher, Short, Henry and Sprague systems.

In 1889 the Thomson-Houston Company acquired the patents of Bentley, Knight and Van Depoele. In 1890 the Edison General Electric Company took over the Sprague Electric Railway and Motor Company, acquiring the patents of Mr. Sprague. In 1891 the most important matter of the interference of the railway companies with the ground returns of the telephone companies was settled by a decision in the Supreme Court of Ohio, sitting at Cincinnati, in the January term of that year.

During this period Siemens & Halske in July, 1889, installed at Budapest, Austria, a conduit railway of considerable size. The success of Sprague's operations at Richmond gave confidence to financial interests, and the next period is marked by a considerably increased rate of acceleration in the development of electric traction.

It may be well at this time to comment upon the attempts which have been made to operate electric railway cars by means of accumulators carried upon the cars. A conclusive experiment was that attempted on Madison avenue, New York city, during the year 1890. Fourteen cars were used, running between the Post-office and a charging station at the car stables in Eighty-eighth street, a total distance of about five miles. The motors employed were of the Reckenzaun type, and 110 cells of accumulator were installed in each car in two long boxes. The cells were of the Julien type, containing pasted plates. This system, however, seemed impractical because of the high depreciation of the batteries. Several other lines have since been operated in various portions of the country. For a long time a system was operated on Thirty-fourth street, New York city. Better fortune seems to have attended the efforts on behalf of accumulator traction abroad.

Concerning the introduction and development of surface-contact systems, which apparently would be the ideal method of car propulsion, eliminating the unsightly overhead system and the costly open-slot construction, there is not much to record, the Diatto and the Clairet-Vuelleumier systems in Paris; the Lorain system in Wolverhampton, and the Pullen system in the United States having achieved an ordinary degree of success.

In 1888 and 1889 Leo Daft equipped about two miles of the Ninth avenue division of the New York elevated lines, operating upon them an electric locomotive of considerable power. This project was allowed to lapse, however.

About this time the introduction of cross-country roads began, and the use of alternating currents, both of high and low tension, was seriously considered. In February, 1894, H. Ward Leonard presented a paper before the American Institute of Electrical Engineers, suggesting the use of single-phase alternating current at 20,000 volts. The car equipment included a motor-generator, the single-phase synchronous motor operating at 500 volts, being direct-connected to a separately excited generator. A small exciter furnished current for the motor and generator fields and for the fields of the motors connected to the axles. The brushes of the driving motors were connected directly to the brushes of the generator. The synchronous motor ran continuously, driving the generator.

In 1896 Bion J. Arnold proposed the use of high-tension current in plans he developed for a road to run from Chicago to the lake region.

It was a little earlier than this—in 1890—that a line on the South London road was equipped with electric locomotives, the gearless motors having armatures on the axles of the drivers. Later, in 1893, the Liverpool (England) Overhead Railway was put in operation. In the spring of the same year the Intramural Railway was constructed at the World's Fair, Chicago. In 1895 the Metropolitan West Side Elevated Road, in Chicago, was electrified. In the following year the Nantasket Beach road, a branch of the New York, New Haven & Hartford, was put into operation, and September saw the electrification of the Lake Street Railway in Chicago. There had been few attempts,

however, to replace steam road equipment with electrical apparatus, the most important up to this time being the construction by the General Electric Company of three locomotives, each weighing ninety-two tons, and developing 1,000 horse-power, for the tunnel under the city of Baltimore, Md., operated by the Baltimore & Ohio Railroad. This was in 1895.

In the summer of 1900 the Central London Underground Railway, between the Bank and Shepherd's Bush, was opened, the third-rail system being employed. The City & South London Underground Railroad in London was opened in 1894; also a third-rail system.

Along with the great extension of the use of electric motors for railway work, control methods, trolleys and all other portions of the system were rapidly developed. In the earlier types the windings and commutators of the motors were exposed to the dust and dirt and moisture of the streets. In 1891, with the design of the four-pole motor adapted to single-reduction gearing, efforts were made to produce enclosed types of street railway motors. Soon the gearing was enclosed in tight metal cases filled with oil, this contributing both to the life and quietness of this portion of the car's mechanism.

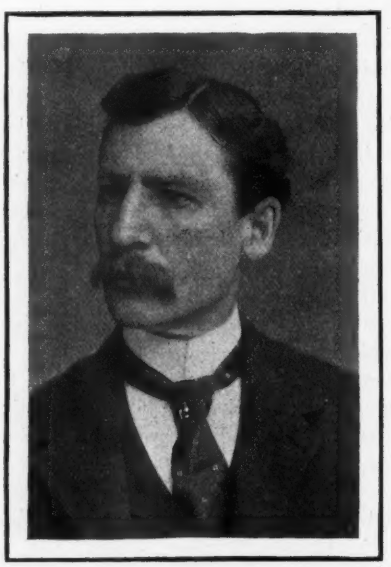
In 1890 the Westinghouse Electric and Manufacturing Company entered the street railway field as a rival of the combined Thomson-Houston and Edison interests. The rivalry of these two great corporations has done much to promote the rapid development of electric railway equipment.

In the spring of 1897 Mr. Sprague was requested to act as consulting engineer of the South Side Elevated Railroad, Chicago. It was upon this system that the first application was made of multiple-unit control. In November of 1897 a test train of five cars was put in operation in Chicago; on the twentieth of April of the next year, twenty cars, and three months later, locomotives had been entirely abandoned. This was a conclusive demonstration of the practicability of controlling any number of units in a train from a master switch located on the platform of any of the moving cars.

This brings us to comparatively recent times. The development since 1900 has continued both along the lines of utilization of direct and alternating currents.

In August, 1901, Ganz & Company, of Budapest, installed on the Valtellina line, running through Lecco, Colico and Sondrio, Italy, for a length of sixty-seven miles, an alternating-current system, the transmission being at 20,000 volts, the motors operating with 3,000 volts in each phase. In the same year, between September and November, Siemens & Halske and the Allgemeine Elektricitats Gesellschaft, acting for the "Studiengesellschaft," representing the German government, installed an alternating-current traction system on a portion of the military line outside of Berlin, running between Marienfelde and Zossen. The current was received on the car at 12,000 volts, three-phase, and transformed on the car to 450 volts. It was announced that on October 6, 1901, this car made a speed of 125 miles per hour.

CHARLES J. VAN DEPOELE.



FRANK J. SPRAGUE.

The year 1901 also witnessed the opening of the first portion of the third-rail system from Milan to Varese, Italy, and the installation of accumulator lines from Milan to Monza, and from Bologna to San Felice. The Burgdorf-Thun system in Switzerland was also inaugurated, the primary line operating at 20,000 volts, the three-phase motors taking current at 1,000 volts.

This was a period of great activity on the part of numerous investigators, the principal work being done along single-phase lines by Finzi, E. Arnold, Deri, Schuler, Latour, Winter-Eichberg, Thomson and Steinmetz.

In June, 1902, Bion J. Arnold, at the Great Barrington (Mass.) meeting of the American Institute of Electrical Engineers, described an electropneumatic system of railway traction, utilizing high-tension alternating current. An air-compressor system is employed for starting the motors and for supplying power for propulsion through cities, where the high-tension conductor would not be allowed.

In September, 1902, B. G. Lamme presented to the American Institute of Electrical Engineers a paper describing the Washington, Baltimore & Annapolis single-phase railway. This system called for the use of single-phase alternating current in generators, transmission lines, trolley car equipment and motors.

On October 27, 1904, the great subway system in New York city was opened to the public.

On November 12, 1904, a company of newspaper men and representatives of railway interests inspected the ninety-five-ton locomotive built by the General Electric Company and the American Locomotive Works for the New York Central & Hudson River Railroad. The normal rated horse-power of these machines is 2,200, the maximum being 3,000. The normal drawbar pull is 20,400 pounds, the maximum 32,000 pounds. These engines are capable of making a speed of sixty miles per hour, drawing a 500-ton train. The principal feature of the locomotives, which are operated by direct current, is the use of gearless motors, the armatures of four of which are mounted directly on the axles of the drivers.

On May 16, 1905, the Westinghouse-Baldwin single-phase, alternating-current locomotive was demonstrated at East Pittsburg, Pa. This locomotive has a weight of 135 tons, each axle carrying a 225-horse-power, single-phase series motor of the single-reduction-geared type, making a total of six motors for each locomotive. The machine is built in two halves, each having one six-wheel truck with a rigid wheel base. These are

Mr. WALTER H. WHITESIDE

President of the Allis-Chalmers Company

Whose energy and resourcefulness have won for him a rapid rise as an organizer and developer of large interests

coupled together and are intended to operate as one unit, or each half may be operated separately if desired. The machines are designed for twenty-five cycles with a trolley voltage of 5,000. Auto-transformers on the locomotives reduce the current to 225 volts for use at the motors. The machine develops a drawbar pull of 50,000 pounds at ten miles per hour, and is intended for slow freight service.

The Westinghouse company has also developed, for service on the New York, New Haven & Hartford Railroad, a locomotive equipped with four 250-horse-power gearless motors requiring about 450 volts at the terminals for alternating current, and 550 to 600 volts for direct current. The direct-current feature is necessary because of the probability of the New York, New Haven & Hartford Railroad Company making use of the terminal in New York city of the New York Central & Hudson River Railroad Company, which is operated by direct current.

The new electric locomotives which have been built for the Simplon tunnel by Brown, Boveri & Company, of Baden, Switzerland, were originally intended for the Valtellina Railway. The locomotives are supported upon two trucks, each of which has two axles. The distance between the wheel centres of each of the trucks is fixed at a minimum of seven feet six inches, while the two inner axles are nine feet eight inches apart. The latter axles are used as driving axles. For the transmission of the movement from motor to driving wheel, the use of gearing has been excluded. Two three-phase motors are placed between the driving axles, the motors being coupled to the driving wheels by a driving bar. The two motor shafts are connected by cranks to a common driving bar which runs across between them. From the middle of this driving bar two side bars are connected on either side with one of the driving wheels of each truck. The total weight of the locomotive is sixty-eight tons, and the capacity of the two motors, in normal running, is 900 horse-power.

The Krizik Company, of Prague, Austria, has constructed an electric locomotive to replace the steam locomotives now in use on the Vienna (Austria) city lines. The locomotive is equipped with two direct-current motors geared to each axle. The current is brought on a three-wire system at 3,000 volts between the trolley wires, which form the outer connections, and a ground connection forming the third conductor. Two motors on each side of the ground wire are permanently connected in series along with the starting resistance. With the four motors in series, each one receives 750 volts. The motors are suspended on each side of the axle, both motor pinions meshing into a common gear wheel mounted upon the axle.

One of the important events in the electrification of steam railways was the throwing open to the public of a portion of the Long Island Railroad running between Long Island City and Flatbush avenue and Rockaway Junction, on July 26, 1905. This is operated by a third-rail direct-current system.

Another important electrification was that of the West Jersey & Seashore Railroad, a branch of the Pennsylvania Railroad running between Atlantic City and Camden, N. J. This was opened on September 18, 1906.

In January of the present year electric locomotives were placed in regular operation on the New York Central & Hudson River Railroad, and on January 22 the first electric train ran into Rochester, N. Y., on the Erie Railroad. The New York Central equipment, as has already been mentioned, is a third-rail direct-current system. The Erie electrification uses motor cars equipped with single-phase motors and multiple-unit control for operation from an 11,000-volt trolley wire at twenty-five cycles.

It seems fitting to close this article with reference to the classical paper presented by L. B. Stillwell on January 25 of the present year to the American Institute of Electrical Engineers. This was entitled, "On the Substitution of the Electric Locomotive for the Steam Locomotive," and was prepared in collaboration with Henry St. Clair Putnam. Mr. Stillwell proposes the entire electrification of the steam roads in the United States, and suggests the standardization of equipment along alternating-current lines at fifteen cycles. Mr. Stillwell calculates that for the equipment of the entire railway system of the United States, as now existing, an aggregate power-house equipment capable of supplying continuously 2,100,000 kilowatts would be required.

New York's Telephone Development.

By H. K. McCann.

ON January 1, 1881, there were in service in Manhattan and the Bronx 2,973 telephones. Twenty-six years later, on January 1, 1907, there were in service and under contract in this territory over 225,000 telephones; in Greater New York, 300,000 telephones, and within the metropolitan area, which may be said to be all that territory within a radius of thirty-five miles of New York City Hall, there were in service and under contract 389,000 telephones.

This development is practically all the growth of the past twelve years, for in 1894 there were only about 10,000 telephones in Manhattan and the Bronx, the territory which now has more than twenty times that number. The following statistics, which are correct for January 1, 1907, give an idea of the stupendous size of the telephone system in New York city and vicinity:

Telephones in service and under contract in combined territories of New York Telephone Company and the New York & New Jersey Telephone Company	389,000
Central offices	182
Buildings owned and occupied by these telephone companies	60
New buildings in course of construction	6
Square feet of office space occupied by telephone companies	1,094,500
Total number of employés	17,000
Average number of people per telephone	14

These statistics indicate that New York's telephone service has been well managed along both business and technical lines, else the above development never could have been attained.

A comparison of the telephone development of New York with that of foreign cities shows that New York has more telephones than London and the ten other largest cities of Great Britain combined; not only more than Paris, but more than all the telephones in France, Belgium, Holland and Switzerland combined; more telephones than are to be found in the twenty largest cities in Germany.

In view of this exceptional development it is interesting to note the factors which have resulted in bringing the telephone service of New York city to its present standard of supremacy in the tele-

phone world. These factors may be stated briefly as follows:

First—On account of the convenience of the service, which has become a necessity in business and social affairs.

Second—The general appreciation of the ever-increasing value of the service itself; the fact that every new subscriber added to the system increases the scope of the service of all.

Third—Through the introduction of the message rate plan of charging for telephone service, which makes the message the basis of charge and brings telephone service within the means of the small user.

Fourth—By the standardization of telephone equipment and operating methods.

Fifth—The energetic methods pursued by the companies through their sales and publicity departments.

Next to the exceptional value of the service itself, which, of course, is the essential quality that develops any service or product, the message rate method of charging for telephone service, which was introduced in New York city in 1894, has been the strongest factor in the development of the comprehensive and efficient telephone service of New York—a service that is of inestimable value to the community.

In the early days it was the custom to charge a fixed annual rental per telephone, regardless of the amount of service to be rendered the subscriber; that is, regardless of the additional labor and of the additional plant which might be required in other parts of the system, growing out of the increasing use which the subscriber might make of his telephone. This method of charging is known as the flat-rate system. That it should have been adopted by the pioneers in the telephone industry is natural, for during the first stages of development the telephone exchange served but a small number of subscribers in a restricted area, the vast and complicated and expensive provision of lines and equipment which are to-day necessary to handle the traffic of a great city was not then required, and generally there was substantial uniformity in the use of the service by the various subscribers. Even to-day, where the telephone exchange consists of one central office and where the stations to be served are numbered by hundreds rather than thousands, the flat-rate method of charging is found to apply with few exceptions. To meet the conditions surrounding the operation of the first telephone exchange in great cities, the flat rate may be said to have been reasonable and best calculated to develop the industry.

In 1888 the subway laws were passed, and it was necessary to abandon overhead lines and construct a new underground system. There was no chance of benefiting by the experience of others, as there were no other cities here, or abroad, where similar work had been done to any great extent, and after extensive experimental work, new central offices were constructed, and a new method of working the entire system was determined upon.

By 1894 the reconstruction, with underground lines on a metallic circuit basis, was practically completed, and as the plant was in excellent condition, with greatly increased facilities, attention was directed to extending the use of the service by securing new subscribers. To do this it was evident that a new rate schedule must be adopted, and, accordingly, a plan by which the number of messages to be sent should be taken as the basis of the rate was considered and finally adopted tentatively. That the new method was a success is shown clearly by the rapid development of the system which dates from its adoption.

Long before this time it was found that batteries at subscribers' stations steadily became more burdensome. They needed repairs often and the expense of changing them was heavy; also they frequently failed to work. It was felt that a central exchange battery would form the best source of power for the operation of all the exchange lines. Necessity, which is always the mother of invention, evolved a common battery apparatus which, by 1894, was in general use throughout the business districts of New York city, and which to-day is in universal use throughout the metropolitan territory; so that now, instead of working a crank to get central's attention, you simply put the receiver to your ear, the energy being supplied through the common battery located at the central exchange.

With an expanding area over which exchange telephone service must be rendered, and a consequent increase in the average length of line, affecting both investment and working expense, and with an increasing volume of traffic per station, due to the constantly enlarging potentiality of each telephone through the addition of new subscribers, the costs per telephone were found to increase.

In spite of this additional operating expense the development of the message rate method of charging for telephone service has enabled the companies in New York city and vicinity to reduce their charges from time to time. U. N. Bethell, president of the New York & New Jersey Telephone Company, in his annual report for 1906 to the stockholders, says, in this connection:

"The company's policy has been to establish service charges, which, while enabling its stockholders to obtain a proper return upon their investment, would also from the standpoint of its patrons in the various communities within its territory be reasonable and fair. In carrying out this policy the company has reduced and modified its charges from time to time as rapidly and as fully as was warranted by the results obtained. Substantial reductions and modifications were made in 1906. The changes made, while largely reducing the earnings from business in hand at the time they became effective, attracted a large amount of new business, the net result being an increased volume of business at a less percentage of profit per unit of business transacted, and a further popularization of the service.

"As a result of frequent and systematic reductions, the average earnings per station have decreased during the past ten years approximately fifty per cent. Although a little more than one-half of the total decrease was made during the first five years of the period, the average has declined in every year, the decline being fairly uniform throughout the entire period."

To maintain an efficient and reliable service, and at the same time to provide increased facilities to handle the ever-increasing volume of new business, both in stations and traffic, which has been created within the past few years, has been a difficult problem from an engineering and operating standpoint.

The New York companies have, however, shown their ability to meet these conditions. Their engineers had already foreseen this huge development before it was fully under way, and had prepared their plans accordingly. Extra underground cable facilities and new central office stations were planned and constructed, and the various departments of construction, maintenance and operation expanded in anticipation of this development. Schools of instruction were installed in the various departments where skilled employés were needed, in order that an ample corps of future employés might be trained and ready for active service.

The best and most satisfactory methods from the standpoint of the public relating

to contracts for service and to the prompt installation of telephones have always been considered of the highest importance in extending the system and giving satisfaction to subscribers. A carefully selected and properly trained force of men who come directly in touch with the public has been developed, and offices have been opened throughout the companies' territory to accommodate their patrons in every possible way.

The development of the great telephone system demanded by the dense population and the unparalleled activity of metropolitan New York has gone on in an orderly way from year to year. But the apparent ease with which this has been accomplished has not been due to the simplicity of the problem, but rather because the best minds and the highest trained skill available, backed up by judicious expenditure of money, have been brought to bear on the situation.

Forms of telephone service to fit every need have been adopted. Every hotel in the city is equipped with telephone service to the fullest extent, a telephone being installed in each room or apartment. Factories, office buildings and homes are nearly all thoroughly telephoned. The large department stores have begun to install telephone systems with telephones on every counter throughout their establishments, in order that shopping by telephone may be as easily accomplished as shopping in person; restaurants are adopting the new restaurant service offered by the company, whereby all one needs to do is to ask the waiter and the telephone is brought to the table for use during the meal; in fact, there are telephones everywhere.

On the theory that the possible limits of a community are bounded by the accessibility of the business centre to the people who have interests there, it can be readily seen that the development of the telephone has been a most important factor in the city's growth, for the ramifications of the New York system, its lines to suburban and long-distance points, north, east, south and west, extend the limits of New York, telephonically speaking, all over the United States.

Unquestionably, New York's telephone system has been a very considerable factor in making it the reigning commercial city of the Western hemisphere.

Some Patent Statistics of Twenty-five Years Ago.

By E. G. Siggers.

THE progress and importance of patents for inventions relating to the electrical art during the last twenty-five years is probably best evidenced by the progress of the art itself during that period. Practically every step of importance that has advanced the same and thousands of valueless ideas have been protected by patent. In 1882 one division of the Patent Office was able to handle everything presented along electrical lines. Now three divisions are having difficulty in coping with the applications filed. Then there were but a few basic classes. Now those classes have branched and ramified into numberless sub-classes, many of which are of the greatest importance and require the entire time and services of specialists therein. It is interesting to note that on February 14, 1882, the issue of the Patent Office for the week was 354, while on February 16, 1904, the complete weekly issue was 982. The electrical patents have increased in proportion. Of course, many of the basic features underlying the field of electricity were known to some extent at least in 1882, and patents thereon had been granted. But these patents disclose mere theoretical propositions and crude outlines rather than practicable devices, and by far the greater number of the patents since granted cover improvements that have brought the original crude outlines and ideas into the present highly developed machines and systems. The modern mechanisms, therefore, almost without exception, are composite affairs, in which the excellent ideas of numberless inventors have been incorporated, while the worthless plans and suggestions of others have been eliminated. The Patent Office is the storehouse in which the good, bad and indifferent propositions will be found.

To fully appreciate what has been accomplished in the various arts during the last twenty-five years, the classes of "magneto-electric generation," "system of distribution," "electric railways" and "electric elevators" may be taken as examples, and the following is a brief summary of some of the earlier patents in the same. The progress of these classes will be evident from a consideration of these earlier patents as compared to the present character of these particular fields.

In "magneto-electric generation" the state of the art was as follows:

Somnenburg & Rechten had patented a machine for killing whales by electricity (patent No. 8,843, March 30, 1852—the earliest United States patent in this art). The so-called "Alliance" machine was in use to some extent for seaboard illumination. (Represented in this country by the patent to Shepard, No. 15,596, August 19, 1856.) These machines were provided with permanent field magnets. Wilde had patented a machine that was intermediate between those having permanent field magnets and those which had electro-magnets excited by the current of the machine itself. (Patent No. 59,738, November 13, 1866.) Gramme and d'Ivernois had patented a machine having a continuous armature winding which, so far as United States patents go, may be regarded as the progenitor of the modern dynamo-electric machine. (Patent No. 120,057, October 17, 1871.) In 1875, April 13, a patent was granted to Moses G. Farmer embodying the principle announced in 1866 by Siemens, Wheatstone and Varley of exciting the field magnets by the currents generated by the machine. (Patent No. 161,874, April 13, 1875.) Edward Weston, of Newark, N. J., patented, July 18, 1876, No. 180,082, a multipolar self-exciting machine. The first patented machine having the modern form, with consequent poles, was granted to Holcombe, December 5, 1876, No. 184,966. C. F. Brush, of Cleveland, Ohio, April 24, 1877, No. 189,997, patented a form of machine having an open coil ring armature. Edward Weston patented, October 29, 1878, a machine which had all the essential features of the most modern machines, *viz.*: consequent poles and cylindrical ventilated armature with continuous winding. C. F. Brush, July 22, 1879, No. 217,677, introduced the so-called "teaser," which was a high-resistance winding upon the field magnets, connected in shunt to the work for the purpose of maintaining the magnetism of the field magnets when the machine was running, whether the external circuit is closed or open. Prior to this, all machines had their field magnet winding in series with the work and had no excitation except when the working circuit was closed. Edison patented, December 23, 1879, No.

222,881, a special structure of cylindrical armature. Thomson and Houston, January 13, 1880, introduced their three-coil armature. Brush patented a regulator consisting of a shunt around the field magnets, including a variable resistance, February 17, 1880, No. 224,511. C. A. Seeley patented, June 22, 1880, No. 229,191, an armature in the form of a disc, wherein the active wire was radial. Sawyer, July 20, 1880, No. 230,345, patented a regulator which varied the number of active sections of field-magnet winding. Von Heffner-Alteneck patented, November 9, 1880, No. 234,353, a multipolar alternating-current machine having a portion of its current commutated for exciting the field magnets. Edison, June 14, 1885, No. 242,898, brought out an armature having its conducting parts formed of heavy copper bars. Van Depoele, May 16, 1882, No. 257,990, patented what is known as a motor-generator, or rotary transformer, in which there are two armature windings, one taking current from a line and driving the machine as a motor, while the other winding acts as a generator. Irwin, August 8, 1882, No. 262,421, patented a machine in which regulation was effected by changing the inductive relation of field magnet and armature. Patent to Wenstrom, No. 292,079, January 15, 1884, shows the first of the so-called "iron-clad" machines. An armature winding for drum armatures in which the coils might be prepared in advance and placed on the core as desired, was patented to Eickemeyer, February 14, 1888, No. 377,996. The employment of carbon collector brushes is represented in the patent to Van Depoele, February 25, 1890, No. 422,265. A form of machine in which the armature wire is stationary and is affected by the closing and opening of the magnetic circuit is shown in the patent to Sawyer, February 8, 1881, No. 237,632, and in a more improved form in Stanley and Kelley, June 13, 1893, No. 499,446. Machines on a vertical shaft, such as are used at the works at Niagara Falls, are shown in the patent to Sellers, June 5, 1894, No. 520,940.

The sub-class of "systems of distribution" includes systems of distribution of electricity for lighting purposes by means of transformers. Prior to 1873 there was nothing done of any consequence, and the state of the art may be represented by the patent to Fuller, November 26, 1878, No. 210,317. The first attempts at a commercial employment of transformers for purposes of distribution were based on the patent to Gaulard and Gibbs, October 26, 1886, No. 351,589. A transformer system for constant current is brought out in the patent to Thomson, April 2, 1889, No. 400,515. The relation of counter-electromotive force to direct electromotive force, which renders transformers connected to line in parallel self-regulating, is found in the patent to Kennedy, July 16, 1889, No. 407,294 (re-issue September 24, 1889, No. 11,031). The monocycle system is represented by Steinmetz, January 29, 1895, No. 533,248.

In the class of "electric railways" there was nothing in this art prior to 1873. Some of the most prominent features in the growth of the art may be represented by the following patents: Overhead direct and return conductors with double trailing trolley—Finney, January 2, 1883, No. 270,186; overhead conductor trailing trolley, ground return. Finney, September 18, 1883, No. 285,353; overhead conductors, upward pressed trolleys, double trolley, Van Depoele, December 4, 1888, No. 394,038; overhead conductor with upward spring-pressed trolley—Van Depoele, January 19, 1892, No. 467,448; underground conductor with slotted conduit—Knight, September 23, 1884, No. 305,731; underground conductor with contacts projecting above the surface of the ground—Painter, June 23, 1885, No. 320,679; underground conductor, the circuit being closed by the action of a magnet carried by the car—Wynne, January 7, 1890, No. 419,094; railway system in which an alternating current is transformed to a direct current for driving the motor—Westinghouse, May 28, 1889, No. 404,139; motor elastically mounted so as to be independent of the vibration of the car, represented by Field, April 10, 1888, No. 380,880; electric railways operated by polyphase currents, represented by Badt, January 10, 1893, No. 489,597.

The following patents are cited as illustrations of the growth of the art of operating elevator motors by electric power: Hydraulic elevators electrically controlled, Smith, September 3, 1889, No. 410,212; elevators, in which the electric motor is carried on the car, with connected gearing engaging rack-bars in shaft; Sheridan and Gorn, No. 259,593, June 13, 1882, and Blades and McKee, No. 462,527, November 3, 1891; elevators having motor stationary and automatically controlled by switch mechanism on car or landings; Wheeler, No. 324,621, August 18, 1885, and Eickemeyer, No. 454,462, June 23, 1891; safety devices to break motor circuit when elevator door is opened, Ongley, No. 389,853, September 18, 1888.

At the same time it is curious to note that very few absolutely new ideas have been brought forward. For instance, the crude conception of electrical communication without the use of wires and the mercury vapor lamp is found in expired patents, thus showing that while the original conception is an essential, it is by no means the only essential. The value of the patents, therefore, of the last twenty-five years would appear to be found, not so much in the disclosure of pioneer inventions in new realms of thought, but in making practical and useful the incipient but valuable germs which were previously presented to the world in an inchoate and impractical form.

World's Copper Output.

A statement published in the *London Financial Times* gives the estimated production of copper of the world in 1906 at 730,000 tons, as against 708,000 tons in 1905 (presumably long tons of 2,240 pounds each). The *Times* gives the following particulars:

"The output of the United States increased from 391,400 to 413,000 tons, and there was exported 211,100 tons, as against 247,100 tons in 1905. [American official figures, however, show that the exports of copper in 1905 were 238,798 long tons, and in 1906, 203,014 long tons, a decrease in exports of 35,784 tons.—B. M.] The total imports into Europe increased 20,500 tons, of which no less than 12,700 tons came from Japan. Australia sent 8,100 tons and Mexico 1,000 tons more than the previous year. On the other hand, consignments from Chile decreased 2,300 tons, from Peru 2,100 tons and from Cape Colony 1,000 tons.

"The principal countries consuming copper were: United States, 300,300 tons, as against 273,792 tons in 1905; United Kingdom, 80,451 tons, as against 60,491 tons; Germany, 165,107 tons, as against 136,875 tons, and France, 56,328, as against 48,619 tons.

"The requirements of England were so heavy during 1906 that there was a material falling off in transshipment business, exports having declined 7,800 tons. Germany increased her exports over 4,000 tons. Throughout the year the average of stocks in England and France was 6,600 tons, as against 10,500 tons in 1905, and the average total visible supply was 11,800 tons, as compared with 16,400 tons. The record of average deliveries was 7,900 tons, as against 7,300 tons. The average price of standard was $425.42 per ton, as compared with $338.67 in 1905, and the average price of ingots was $449.12."

TWENTY-FIVE YEARS OF THE "ELECTRICAL REVIEW."

Twenty-five years ago last month—February 15, 1882—the ELECTRICAL REVIEW was born. At that time there were no other journals of general circulation in the electrical field.

When the REVIEW, which had been published semi-monthly for one year, was made a weekly journal (March 22, 1883), it stood alone. There were no other electrical weeklies in existence. There were two or three monthly publications at that time which have since been discontinued.

Under the same management and dominated by the same high ideals by which it began, the ELECTRICAL REVIEW has progressed until it stands to-day, we say in all modesty, as the most interesting, the most ably edited and the most enterprising technical journal representative of that vast field that includes every branch of electrical endeavor. It has never been limited, through its ownership or environment, in influence or effort nor have sordid motives ever controlled its management and methods.

It seems proper in this issue, as the ELECTRICAL REVIEW enters upon its second quarter century of life, that there should be presented in its columns a brief account of what has been accomplished during the past twenty-five years, with some present estimates of the state of the art and prophecies as to the future.

To the able and expert staff of contributors, as well as to the alert and far-seeing patrons of its commercial-announcement columns, the ELECTRICAL REVIEW extends its thanks and appreciation and cordial good wishes.

Our Portraits.

In this issue there are presented a number of portraits of men, well known in the history of electrical development, who have been especially conspicuous in their several fields of endeavor. It is with particular satisfaction that we call attention to the four handsome portraits of the leaders in the commercial development of the electrical industry. These men are at the head of immense undertakings and represent truly the spirit of enterprise and faith which has made the electrical epoch the greatest in the history of the world.

The New York Central Wreck and the Electrical Commission.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

We enclose herewith a copy of a joint letter which we have this day sent to Assistant District-Attorney Nathan A. Smyth, in charge of the investigation in relation to the New York Central wreck of February 16, before Coroner Schwannecke.

Since testimony has been offered at this hearing from which the public might infer that the commission of which we were members was in some way responsible for this wreck, we feel that our position should be definitely understood by the public.

Very truly yours,
(Signed) FRANK J. SPRAGUE.
(Signed) BION J. ARNOLD.

NEW YORK, March 4, 1907.

THE LETTER TO THE DISTRICT ATTORNEY.

The letter to Assistant District-Attorney Smyth, mentioned above, follows:

For some days you have been conducting an inquiry before Coroner Schwannecke to ascertain the causes of the disaster of February 16 on the New York Central road, and to place, if possible, the responsibility therefor. From remarks made at the hearing of last Saturday we infer that it is now nearing a close.

In the course of this investigation it has been suggested that there was some remissness on the part of the Electric Traction Commission which had general charge of preparing the plans for the change from steam to electrical operation. The undersigned were members of that commission, which was in existence for the four years ending last December, and are therefore familiar with the details of its work.

The duties and responsibilities of that commission, while numerous, were not universal. Its outside members were neither officers of the road nor in charge of any of its departments; in fact, during the latter part of its existence its duties were almost nominal, as but few meetings were called during a period of several months. At this time the immediate active work of installation in the electric zone was carried out under the supervision of another body known as the construction committee, of which we were not members, but which was composed exclusively of heads of departments and others in the continuous employ of the railroad, who were presumably in daily touch with the work.

Furthermore, no matter who designed or installed the electrical equipment, its upkeep and operation, as well as the maintenance of the tracks, the determination of schedules, and the discipline of the operating forces were matters belonging solely to other hands than ours, with whom we were not in touch, and over whom, in our capacity as advisory engineers, we had no control whatever.

During the investigations, both by the State Board of Railway Commissioners and the coroner's jury, we have been in New York, subject to call at any time; in fact, one of us came voluntarily from Chicago to be available if wanted. We are conscious of no neglect of our duties, defect in plans or equipment, or lack of precautionary tests on our part. We stand ready to assume to its full measure any responsibility properly belonging to us as members of the Electric Traction Commission, but in the absence of any request for our evidence we protest against the possibility of being charged with responsibilities which we believe belong specifically to others, or which are the result of an accident, the causes of which are not yet fully determined.

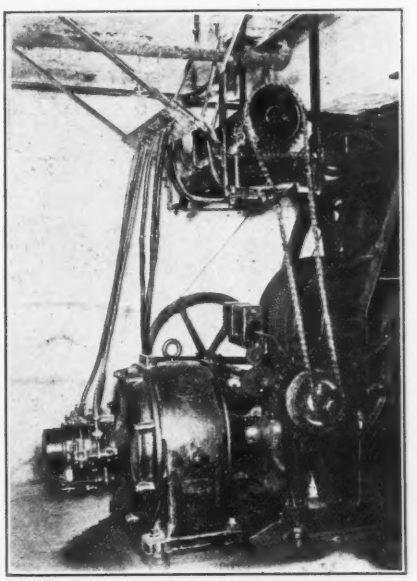
We have no desire to force ourselves upon your attention, but if it is your wish to arrive at facts in regard to the responsibility of this commission, we suggest that that desire can best be obtained by calling all who are familiar with those facts.

If, however, it is now your judgment that any measure of responsibility rests upon this commission, then we demand the right to be heard.

Respectfully yours,
(Signed) FRANK J. SPRAGUE.
(Signed) BION J. ARNOLD.

Electrical Equipment of the Dwinell-Wright Company, Boston, Mass.

The many advantages derived from the use of motor-driven machinery are becoming generally recognized, and electric drive has invaded practically every class of industries. The economical operation, by reason of increased output, ease of control and flexibility, are all obvious features that readily appeal to manufacturers. Further, the cleanliness of electric motors makes them peculiarly adaptable to operating machinery for the preparation of food products. The new building of the Dwinell-Wright Company, coffee roasters and spice grinders, Boston, Mass., furnishes an excellent example of a modern electrical equipment for a business of this kind. The entire plant is operated by electric motors on a three-phase, sixty-cycle, 220-volt system of distribution, and the following description illustrates the various applications.



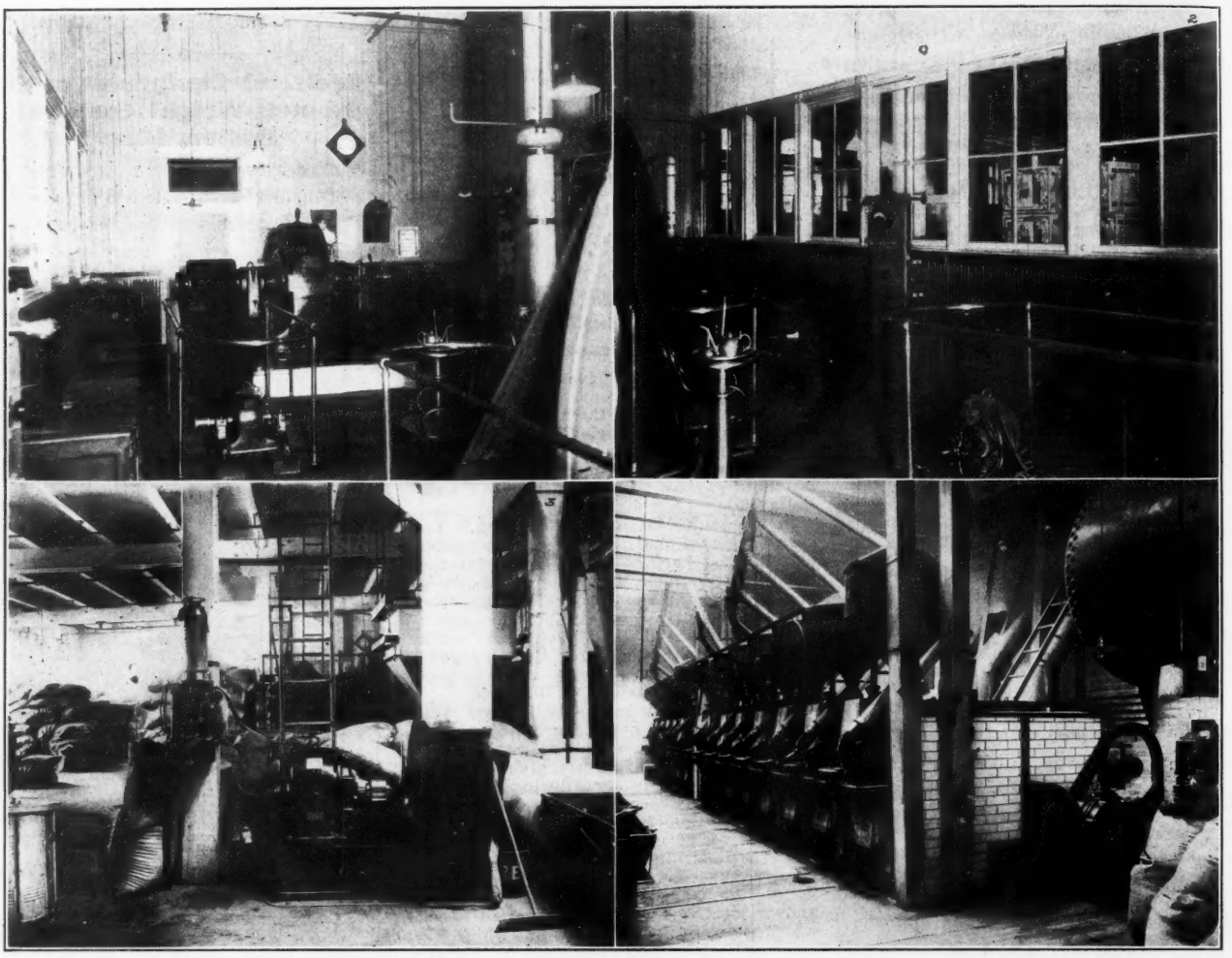
ELEVATOR DRIVEN BY FIFTEEN-HORSE-POWER INDUCTION MOTOR.

Adjoining the office on the first floor is

the coffee testing room, equipped with a battery of six roasters driven by a one-horse-power induction motor. In this department samples of various grades of coffee are roasted for the benefit of prospective customers. With the exception of the small space occupied by the boiler room and coal pocket, the entire sub-basement is devoted to the receiving and storing of green coffee obtained from Arabia, Brazil, Jamaica, Java, Venezuela and other points. A large part of the basement proper is also devoted to the storage of raw coffee. On this lower floor the first step in the cleaning process is carried out, after which the coffee is conveyed to the next floor by a bucket elevator, whence it passes to the separating machines. After cleaning, the various sized coffee beans are deposited in separate metal bins. On the second floor the separating and grading machines are belt driven by a seven and one-half-horse-power induction motor, which also operates the bucket elevator mechanism. On the same floor there is a three-horse-power induction motor driving two glueing and folding machines, an automatic weighing machine and an air-pump. These machines are used in connection with the packing of spices, the process being semi-automatic.

From the metal bins on the second floor the separated coffee is next carried to the top floor, deposited in large bins, and after being passed through an automatic weighing machine is drawn off in 100-pound sacks. Upon this floor the coffees are roasted and ground as ordered, the capacity of the roasters being 70,000 pounds per day. The coffee is stored on the top floor prior to roasting and is sent to the roasters by two bucket elevators. The fourteen seven-foot roasters are driven by a ten-horse-power induction motor using silent chain drive. Quick cooling after roasting is essential, as the hot coffee would grow dark in color and actually take fire if left in a considerable mass without having air drawn through it. The coffee is cooled by a forty-five-inch Sturtevant steel exhaust fan driven by a seven and one-half-horse-power induction motor, and is then dumped into a hopper, after which it passes on, first, to a revolving screen which sifts out all the materials; second, to a chaff pipe up which there is a light suction of air to remove particles lighter than sound coffee, and third, to a stoner pipe up which there is a current of air sufficient to lift the coffee itself, leaving any heavy particles, such as stone and nails, at the bottom. The clean coffee carried up by the air current is deposited in the hopper overhead, from which it is transferred by gravity to storage bins in the storage room below. The two revolving screens are driven by two one-half-horse-power induction motors direct-coupled to the driving shafts. The stoner and chaff pans are driven by two direct-connected seven and one-half-horse-power induction motors.

The grinding of the coffee is carried on on the uppermost floor of the building, four grinders and a bucket elevator for



DWINELL-WRIGHT COMPANY, BOSTON, MASS. 1.—120-KILOWATT THREE-PHASE, SIXTY-CYCLE GENERATOR BELTED TO A 150-HORSE-POWER BROWN ENGINE. 2.—SMALL LIGHTING GENERATOR AND SWITCHBOARD. 3.—FORTY-FIVE-INCH EXHAUSTER DRIVEN BY TEN HORSE-POWER INDUCTION MOTOR. 4.—FOURTEEN COFFEE ROASTERS DRIVEN BY TEN HORSE-POWER INDUCTION MOTOR.

feeding them being driven by a one-horse-power induction motor. After being ground the coffee drops by gravity directly from the mills into automatic weighing machines on the fourth floor. Running from the basement to the top of the building is a link belt elevator and lowerer for 100-pound packages, driven by a two-horse-power induction motor located on the top story.

On the fourth floor four automatic weighing machines are operated by a five-horse-power induction motor. This motor also drives the carrying belt system which disposes of the various cans of coffee after they are packed. The packing is carried on in two departments—whole coffee and ground coffee—and the entire floor is devoted to packing for shipment. On this floor is an outfit of box-making and nailing machinery, driven by a two-horse-power induction motor. There are also two one-half-horse-power induction motors operating screeners, and a one-half-horse-power motor which drives sifters.

The third story and a part of the second are occupied by the spice department. The motor equipment for these floors comprises the following: One ten-horse-power Westinghouse induction motor driving a thirty-inch Holmes & Blanchard cayenne pepper mill and bucket elevator; one ten-horse-power induction motor, connected to drive, one at a time, three vertical spice grinders, pepper sifters and pulverizers; one ten-horse-power induction motor operating a thirty-six-inch grinder, two elevators and two sifters; one ten-horse-power induction motor operating two iron mills, feeding and sifting apparatus. There is a printing office located on the first floor for printing labels, folders, etc., driven by a two-horse-power induction motor. The equipment, consisting of a total of twenty-nine machines, is completed by two type F motors of fifteen-horse-power capacity operating two Moore & Wyman drum type elevators each of 4,000 pounds capacity, operating at the rate of seventy-five feet per minute. All the above-mentioned motors are of the Westinghouse Company's manufacture.

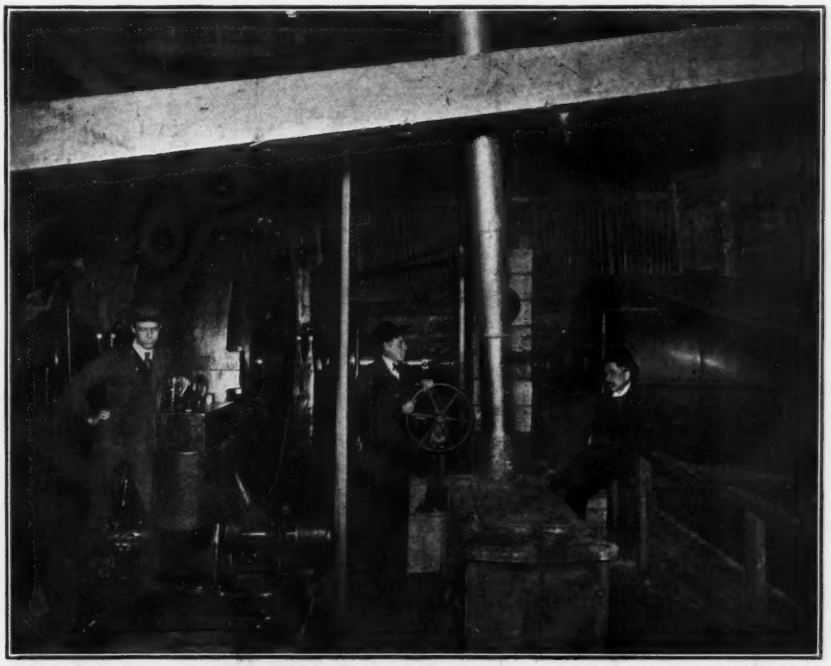
The engine and generating equipment consists of a Westinghouse 120-kilowatt, three-phase, sixty-cycle, 220-volt, alternating-current generator, belted to a fourteen-inch by thirty-six-inch 150-horse-power Brown engine. Excitation is furnished by a 1.87 kilowatt, 125-volt, direct-current generator. For night lighting purposes there is a four-kilowatt, 250-volt, Westinghouse type S generator, driven by an 8.2 horse-power Sturtevant upright engine. The rated load of this generator is fifteen amperes, and the average load carried is seventy-five sixteen-candle-power lamps.

The switchboard consists of blue Vermont marble panels, on which are mounted the standard equipment of Westinghouse instruments.

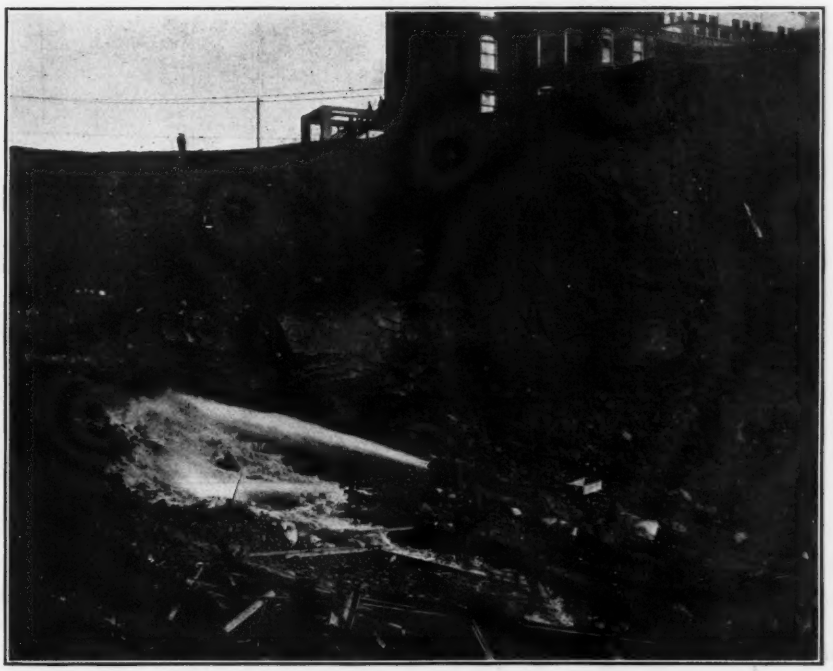
Steam is furnished by a 150-horse-power return tube boiler, operating at 100 pounds pressure.

A Motor-Driven Pumping Plant.

One of the most important of recent installations making use of electricity as motive power is the pumping plant of H. W. Hawley at Seattle, Washington.



MOTOR AND AUXILIARIES, HAWLEY PUMPING PLANT, SEATTLE, WASH.



SIX-INCH GIANT WORKING ON DENNY HILL, HAWLEY COMPANY PLANT, SEATTLE, WASH.

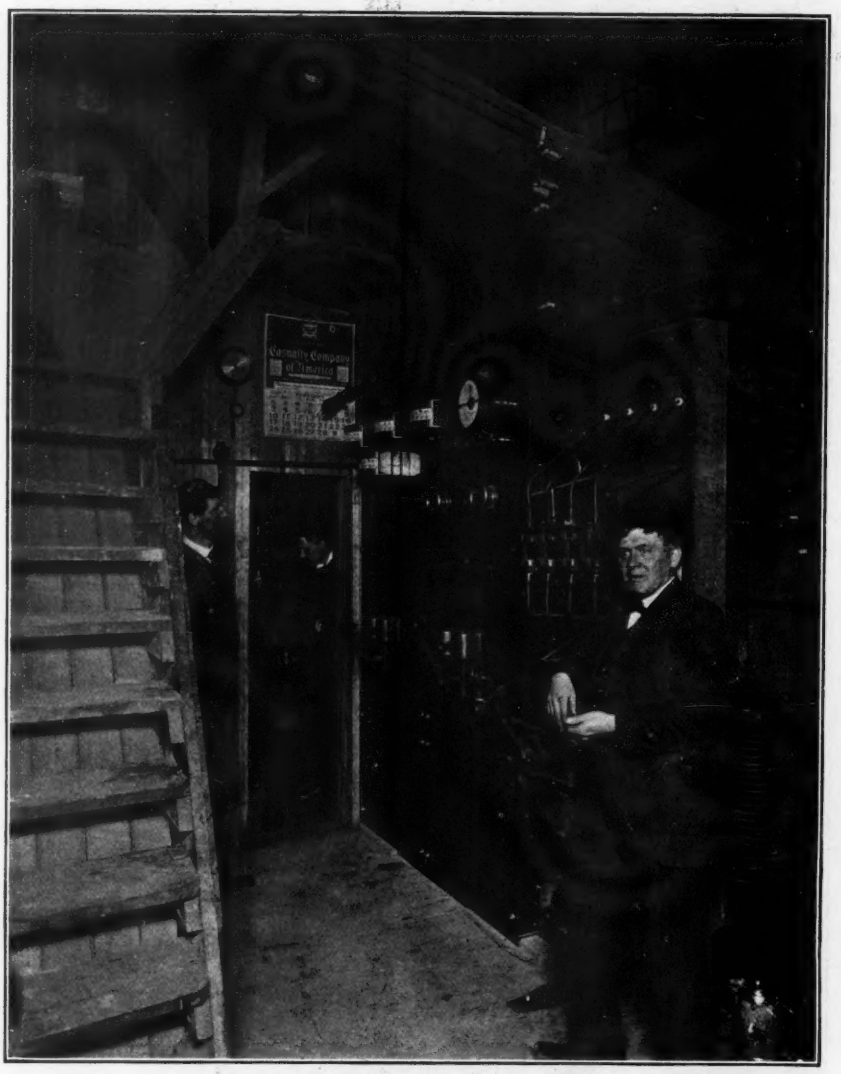
Mr. Hawley is operating the plant mentioned in connection with one of the several hydraulic sluicing systems now engaged in the removal of earth from the hilly section of the city of Seattle.

Heretofore water has been secured for sluicing from the city water system, which derives its supply from Cedar river, distant approximately thirty miles from the city, but owing to the recent large increase in demand upon the city plant consequent to the rapid growth of the city, the municipal authorities have been compelled to discontinue the disposal of water for purposes other than those usually imposed upon such a system. It was owing to this

condition that Mr. Hawley, who had entered into a contract with several private property owners covering the removal of Denny hill, one of the prominent landmarks of Seattle, and the site of the Washington Hotel, decided to install a sea water pumping plant, taking water from Puget Sound at a point approximately 2,500 feet distant from the point of consumption.

The plant consists of a 600-kilowatt, 2,400-volt, two-phase, sixty-cycle, 327 revolutions per minute, Westinghouse synchronous motor carrying the rotor of a forty-horse-power, 440-volt, two-phase induction starting motor mounted on an extension of its shaft. The stator of the starting motor is bolted to a bracket carried on the main bearing pedestal of the large machine. This induction motor has a synchronous speed of 400 revolutions per minute and is controlled through an auto-starter mounted on a separate panel of the switchboard in the regular manner.

Current for the operation of the plant is secured from the system of the Seattle Electric Company; the two-phase 440-volt circuit for the starting motor being carried direct from transformers placed on a pole outside of the station to the starting motor panel. The 2,400-volt, two-phase circuit is carried to disconnecting switches placed outside the building and thence to a feeder panel.



SWITCHBOARD, HAWLEY PUMPING PLANT, SEATTLE, WASH.

The switchboard consists of two panels carrying voltmeters, ammeters, automatic oil circuit-breakers, synchroscope and the necessary bus-bars and small wiring.

The exciter is driven from a pulley mounted on the main shaft of the synchronous motor, and is controlled from the operating panel of the switchboard.

Power is transmitted to a thirty-inch, four-stage Worthington turbine pump, through a friction clutch of special design to the main driving pulley, which is belted to the pump pulley through the medium of a forty-eight-inch, four-ply leather belt. The pulley ratio is such as to operate the pump at a speed of 500 revolutions per minute. The belt tension is adjusted by raising or lowering an idler pulley placed about twelve feet from the pump pulley.

The pump has developed a capacity of 4,000 gallons per minute against a gauge head equivalent to 430 feet and is capable of delivering water at the nozzle of a six-inch giant working at the highest elevation required at a pressure of 120 pounds per square inch. The matter to be excavated consists largely of blue clay and is exceedingly tenacious and difficult to move. However, no difficulty has been experienced in the present instance, and the plant has proved to be thoroughly satisfactory in every way.

The hydraulic end of the plant was designed and furnished by Caldwell Brothers Company, of Seattle, working under contract for the owner. The electrical portion of the plant was designed and erected by Kilbourne & Clark Company, of Seattle, under the supervision of Frederick G. Simpson, chief engineer of that company. All other parts of the installation were installed under the direction of George H. Tinker, engineer for Caldwell Brothers Company.

American Institute of Electrical Engineers.

The 215th meeting of the American Institute of Electrical Engineers was held in the Engineers' Building, New York city, on the evening of Friday, March 1. The secretary announced that at the meeting of the board of directors, held that afternoon, 125 associates were elected and nine associates transferred to the grade of members. It was also announced that, upon the recommendation of the committee upon papers and meetings, it was decided to hold the annual convention at Niagara Falls during the week beginning Monday, June 24.

The following papers were then presented:

"Alternating-Current Electrolysis," by J. L. R. Hayden.

"Electrolytic Corrosion of Iron and Steel in Concrete," by A. A. Knudson.

"Some Theoretical Notes on the Reduction of Earth Currents from Electric Railway Systems by Means of Negative Feeders," by George I. Rhodes.

These papers and the discussion thereon will be summarized in the next issue of the ELECTRICAL REVIEW.

Mr. CLARENCE H. MACKAY

President of the Mackay Companies

A distinguished financier and executive, at the head of a great international system of land and cable telegraph lines

Thomas A. Edison's Views of Significant Electrical Developments.

A REPRESENTATIVE of the ELECTRICAL REVIEW called recently on Thomas A. Edison to obtain his point of view on certain features of the electrical industry. Mr. Edison was found preparing for his annual trip to Florida, where he spends about six weeks recuperating, fishing, boating, and, when the weather is unfavorable, working in his laboratory there. This is located on the west coast of Florida, out of the usual line of travel.

It was mentioned to Mr. Edison that the visit was occasioned by the twenty-fifth anniversary of the ELECTRICAL REVIEW, which is commemorated by this issue. It was explained, in reply to a question from him, that the first issue of the ELECTRICAL REVIEW was dated February 15, 1882.

Mr. Edison was asked to glance back through his experience and to point out what to him seemed the most significant electrical developments during the past twenty-five years. The illustrious inventor took a pad of paper and saying, "Well, lets see what the boys have done," made a list of the branches into which the electrical industry has been differentiated. Looking over this, he said: "You can't take in the telephone, because that's more than twenty-five years old; also, the electric light system must go out, as it was introduced before 1882. The storage battery, too, must be left out of the list. Yet nearly all their vast development has been during the past twenty-five years. That leaves us the electric railroad, wireless telegraphy, long-distance power transmission, and, we may add, long-distance telephony; a number of electrolytic developments, such as the production of soda; the introduction of the electric furnace, X-rays, and electric vehicle traction."

As he ran over the list he stopped at the item, X-rays. "The X-rays," he said, "that was a great discovery, that is a wonderful thing, and it is going to be still more important as years go by. That was one of the great things we did."

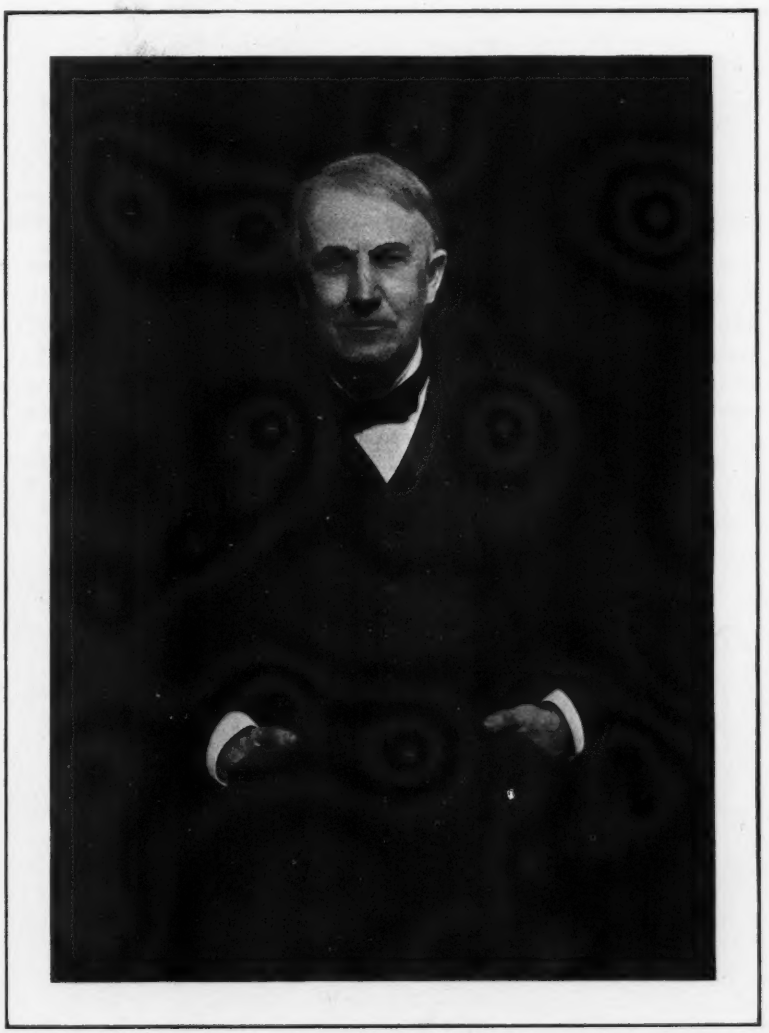


Photo. by Falk, New York. Copyright, 1904, by New York Edison Company.

THOMAS ALVA EDISON.

The next item was electric vehicle traction. "Do you realize," he said, "how important mechanical traction is going to become? It is going to be the system for city use, and, of course, electric traction is going to be the thing. Why, I have figures showing conclusively that a storage battery truck can be operated and kept in good condition for only half of what it costs to maintain a horse-drawn vehicle. Very few people appreciate what this means."

This statement naturally led to a question of the status of Mr. Edison's storage battery. He said: "I have been talking very little about the battery, because the condition is peculiar. In other kinds of work, when the apparatus made develops some trouble, it can be tested, the fault located and set right; but with storage batteries it's different. It takes a year to test a battery thoroughly. Some trouble develops, and when you think you have found it you make a change, and of course you have to change your machinery for making the batteries also. Then you have to wait a year until you see whether you made the right change. I came up against this trouble, and after thinking it over I went about it in this way: I made a list of every possible thing that I thought could be wrong with the battery; in fact, I included in this list everything I could think of, and there were over 400 items. Then I selected six cells for each item and hunted for the trouble, and, of course, found it at last. We have now over 200 sets of batteries running in New York city alone. The Adams Express Company has about 150 equipments. We are just completing the first section of a large building for making the batteries. This section is 200 feet long, sixty feet wide and four stories high, and is to be fol-

lowed immediately by two similar sections."

"Evidently, Mr. Edison," it was said, "you are going to be pretty busy with the manufacture and sale of the storage battery."

"Oh, I don't bother with that," he said; "I leave all that commercial work to my staff."

Mr. Edison seems to have every confidence in the battery as it now stands. He mentioned a number of equipments which he had had out for over two years, which, as far as he could tell, were in perfect condition.

"Mr. Edison," it was asked, "will you, in a word or two, point out those branches of electrical industry in which you think important advances will be made shortly? What, for example, are your ideas regarding the incandescent lamp situation? Will the metallic-filament lamp win the day?"

"The metallic filament is a good thing," said Mr. Edison. "It's a first-rate thing, but it has some commercial disadvantages. We must improve the efficiency of the incandescent lamp; we must bring it down to one watt. The metallic filament is only suitable, as at present made, for large lamps of 50 to 100-candle-power, and that isn't distribution of light—it's concentration. What we ought to have—what we must have—is a ten to sixteen-candle-power unit. I tried a metallic filament myself. I used spools of zircon, magnesia, etc., wound upon it metallic wires coated with aluminum, magnesia, etc., and many feet in length, but I never could get this lamp much above a yellow. A small piece of wire alone glowed brilliantly, but when I put it on the spool it refused to do it. This puzzled me for some time, and it was not until many years afterward that I realized that the Nernst effect was taking place there—that the alumina or magnesia, I forget which, when heated by the filament, became a conductor and short-circuited itself."

"Is it probable," was asked, "that the solution will be reached by a change in the system adapting it to the lamp?"

"No," he said, "the lamp must fit the system. In fact, we ought to have a 225-volt, ten-candle-power lamp. A low-voltage, direct-current system is condemned by the amount of copper it calls for. An alternating system could be used with a transformer, but no system calling for an intermediary device is likely to succeed. This problem came up when I was introducing the incandescent lamp system in New York city. I first figured out a series system, and found that it was impractical because it was not flexible enough. A low-voltage multiple-arc system couldn't be used, because it called for a copper conductor of gigantic proportions."

"Is it probable," it was asked, "that the solution of the lamp problem will be found through a modified carbon filament, rather than a metallic one?"

"I think it will," he said; "in fact, they can already bring the efficiency of the lamp up to two and one-half watts per candle. They could do even better, but the base is poor. It's the base that is giving them the trouble."

"Why not deposit some metal on the carbon, as has been proposed?" it was suggested.

"You can not, at least I never could, deposit anything on carbon but carbon," he said. "That has been tried. Some of the boys tried to deposit silicon on a carbon filament, but no process resembling the ordinary flashing process worked."

"By the way," it was suggested, "you, of course, consider the introduction of the incandescent electric lighting system your greatest achievement?"

"Yes," he said. "Few people realize all that was involved in that work. They seem to think that the incandescent lamp is the whole of it. Of course, it forms only a small part. We hadn't anything to start with; we had to make our lamps, our dynamos, and to devise a system of distributing current; and we had to convince gas users that electricity would be better for them. That was a problem. I solved it by dividing lower New York into sections, each five blocks long, and putting a watchman on each section. He patrolled this two evenings a week—Wednesdays and Saturdays—and made a note of every gas lamp as it was lit. It took him half an hour to make each trip. This gave us close figures; in fact, our estimates were dead accurate. We could go to any man in New York and tell him just how much his gas was costing him. This often caused a good deal of surprise, as the gas user didn't know how we reached the figures. In one case, I remember, our solicitor told the merchant that his gas was costing him $30. 'It's costing more than that,' he said, and, turning to his files, he drew out the bills and showed that they averaged $80. Our solicitor insisted that his figure was correct. This started an investigation, and a bad leak was discovered on the house side of the meter, which evidently had been the cause of the large gas bills."

"What," Mr. Edison was asked, "do you expect will be the result of the present activity in electric railway development?"

"The electric motor is bound to come," he said. "What's the sense of running a steam train between New York and Philadelphia?"

"Will the system of the future be direct-current or alternating?"

"I think it will be direct," he said. "The direct-current motor has suitable characteristics and does not introduce certain disadvantages which accompany the high-voltage alternating-current system."

"What about wireless telegraphy?"

"That's great. That is growing and is going to be a big thing."

"What is the outlook for wireless telephony?" was asked.

"It does not exist," said Mr. Edison.

"In what branch will the most striking advance be made within the next few years?"

"In electric vehicle traction," was the answer. "As I just said, this is going to be the system for cities. It is going to spread marvelously. There are probably few people who have any idea how much this system is going to grow and the changes it is going to make in our cities."

"Have you been following the recent work in physical science?"

"You mean Thomson, Rutherford and Soddy? Yes, I have been reading all of that in a way."

"What are your ideas?"

"Well, it's very pretty and they are finding out a lot of things. Of course, the present theories are only theories, but any theory is a good thing as long as it suggests methods of work, whether it be good or bad."

Mr. Edison seemed to be in particularly good health. His eyes were bright and he showed a good deal of interest in human affairs of the present day not in the list related to the electrical industry.

The Power Plant of the Spokane & Inland Empire Railroad Company.

SOME two years ago or more Jay P. Graves and associates decided to enter the electric light, heat and power field in the city of Spokane in connection with their traction business, at that time in its infancy. Accordingly, they had all the available power sites of any reasonable size and within a reasonable distance of Spokane examined.

The engineer making this examination reported that everything considered, the site now being developed was the best that could be had, and steps were immediately taken to acquire the property. The site selected was about ten miles down the

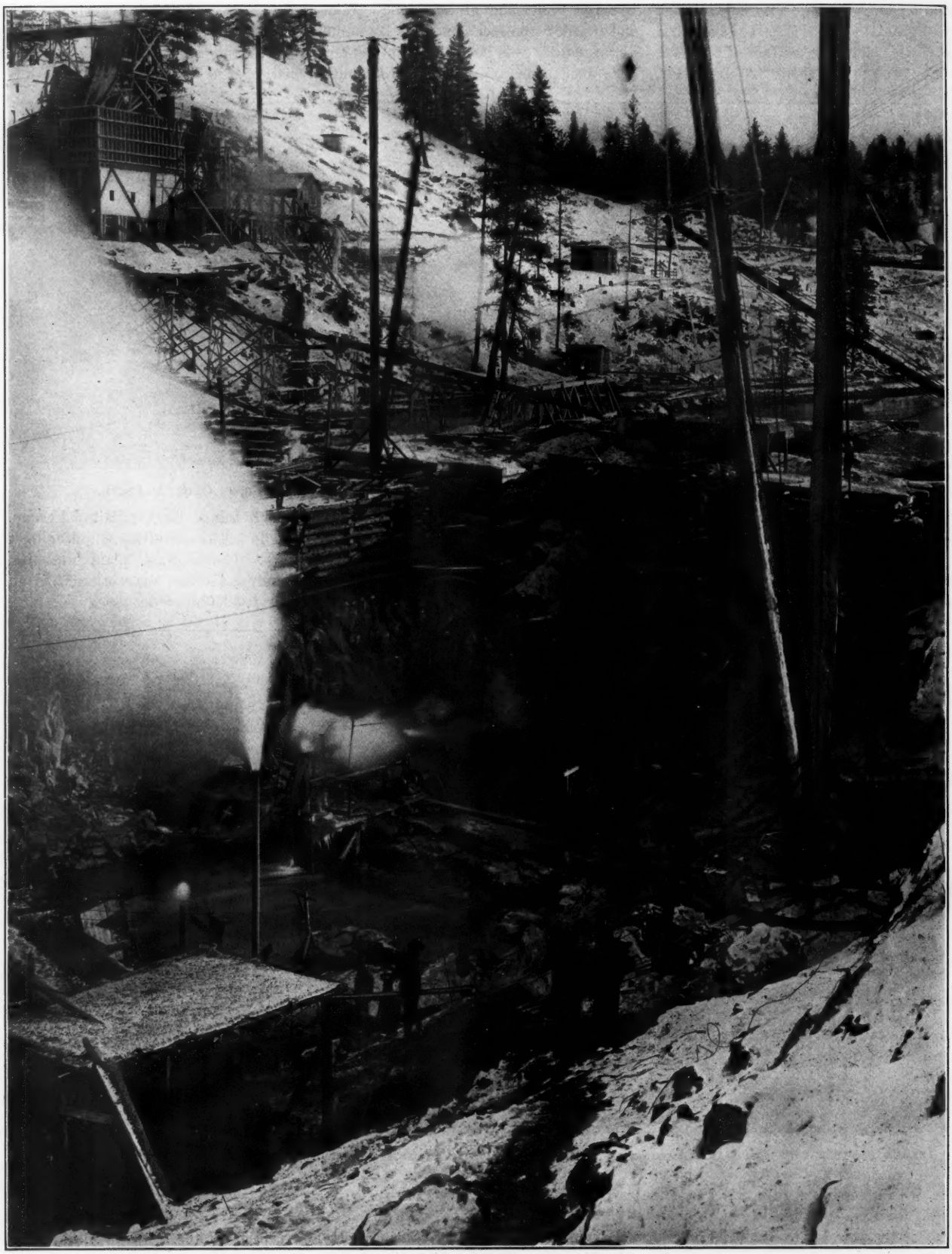
Spokane river from the city of Spokane and at a point where the river cuts through a deep granite rock gorge. It so happened that at this point the surface of the river at high water was about 320 feet wide, while at low water the channel was, on the west side of the river, about 100 feet wide, and approximately twenty feet deep, while on the east side of the river there was a rock bottom, approximately 200 feet wide, which stood above the water at low water. This made an ideal location, inasmuch as the power-house could be placed in the deep part of the stream and the dam, which would have to be about 225 feet on the crest, could be built practically on dry rock. The canyon was deep enough, so that a dam sixty feet high could be built and at the highest water not overflow the rock contour. By building a dam of this height, a lake was created about four and one-half miles long, having a superficial area of about 400 acres, the advantage of such a development, of course, being that with the storage capacity, a peak load on the power plant can be handled at least twice as large as the normal flow of the river would admit without storage.

INLAND EMPIRE SYSTEM, SPOKANE, WASH.—NINE-MILE POWER SITE ON SPOKANE RIVER, IN ORIGINAL STATE.

Having acquired the necessary property, Mr. Graves and his associates decided in April, 1906, to proceed with this development and transferred the property to the Spokane & Inland Empire Railroad Company, and this company employed the firm of Messrs. Sanderson & Porter to be designing and constructing engineers, and made arrangements with William F. Zimmermann to enter the employ of the Spokane & Inland Empire Railroad Company and to act as consulting engineer for this work. Accordingly, plans were immediately made and the work started about July 1, 1906.

INLAND EMPIRE SYSTEM, SPOKANE, WASH.—NINE-MILE POWER SITE ON SPOKANE RIVER, SHOWING RIVER DIVERTED FOR ERECTION OF POWER-HOUSE.

The work was started by preparing the rock on the east side of the river for the reception of the dam, carrying on at the same time the coffer work to divert the water from the deep part of the river on the west side, so that the power-house could be built before the construction of



INLAND EMPIRE SYSTEM, SPOKANE, WASH.—A NEAR VIEW OF THE GREAT EXCAVATION FOR TAIL-RACE TUBES AND FOUNDATION OF POWER-HOUSE, CEMENT PLANT ON HILLSIDE AT LEFT.

the dam was commenced. The design admits of passing the water through the draft tubes while the dam is being erected. Granite rock, a fine quality of gravel, and a fine quality of sand were found on the side hills and within a few hundred yards of the work, thus making ideal conditions for concrete and cyclopean work. The coffer-dams were built largely of timber cut off the land to be flooded, and the water was stopped out by means of log mats covered with hemlock boughs and sealed with fine sand and gravel put in position by hydraulic jets. The concrete plant, having a mixing capacity of 500 yards or more a day, was located on the east side at an elevation above that of the dam crest and directly below the sand and gravel pits, so that the sand reaches the sand bins by gravity, and the gravel is hydrauliced so as to be properly washed into a screen, which screen in turn delivers it to the gravel bin; the gravel being of a very fine quality, the mixture now being used is one, two and five. The machine shop, steam plant and camp is located on the bench or plateau on the west side of the development; the camp being large enough to accommodate about 350 employés; special buildings were built for the engineers, the foremen and the workmen, and the mess house is arranged so that the foremen have their meals in a separate room from the workmen.

The centrifugal pumps are used to keep the interior to the coffer-dam dry. At each corner of the rectangle forming the coffer-dam is located a jib crane with hoists, and these four cranes cover the entire power-house site. Spoil banks are made along the sides of the river so that the excavated material is drawn as short a distance as possible. A large amount of material is also dumped into the river just above the up-stream coffers. The power-house is approximately 110 feet across the stream, eighty-seven feet high from low-water mark and approximately eighty-five feet from the up-stream walls of the power-house to the down-stream walls. The power-house is designed to accommodate four units of 5,000 horsepower each; the initial installation being two such units. The wheel pits are open flumes closed by head-gates, each unit consisting of four forty-two-inch, adjustable bucket type of wheel built by the Holyoke Machine Company, of Holyoke, Mass. The shaft of these wheels runs directly through the dam wall and is connected by a flange coupling to a 3,750-kilowatt, three-phase, 2,200-volt, sixty-cycle alternator, the shaft of which carries an exciter of sufficient size to excite three units. The turbine speed-regulator is placed between the generator and the dam wall. The switchboard, electrically operated, to which nothing but the low-tension wires are connected, is placed in the centre of and on the down-stream side of the power-house, so that the switchboard operator will have full view of each and every machine. A traveling crane, hand-operated, covers the entire length of the dynamo floor. The height of the building is

INLAND EMPIRE SYSTEM, SPOKANE, WASH.—BIRD'S-EYE VIEW OF NINE-MILE POWER SITE ON THE SPOKANE RIVER, JANUARY, 1907.

such that the second floor, thirty feet above the dynamo room floor, is used for all the switchboard apparatus; both high and low-tension switches and their connections being made on this floor.

The dam wall is so constructed that the space between each set of retaining piers is used for the transformers, there being one set of raising transformers, raising the voltage from 2,200, the machine voltage, to 60,000, the line voltage adopted. These transformer rooms are built entirely of concrete, access to them being through fire-proof iron doors.

The transformer rooms are drained directly to the tail-race, and the transformers have an oil-drain with a valve which can be operated from the dynamo room, discharging the oil into the tail-race, and to be used at any time in case of fire. A gantry floor covered by a hand traveling crane extends over all the transformer rooms, also partly over the turbine pits, so that the turbine wheels, as well as the transformers, can be placed or raised out of their positions by a single traveler and delivered to the gantry floor; the gantry floor is on a level with the roadway leading to the power-house. The main water-gates are double leaf sliding gates, operated by rack and pinion hoist, motor driven. Each turbine chamber is supplied with an auxiliary filling valve.

The power-house building will be steel construction, brick filled. The dynamo room floor and the switchboard floor, however, will be reenforced concrete. The dam extending from the power-house to the east bank will be of cyclopean concrete work. There will be a water stop wall on the west side of the building to the west bank eighty-five feet high from low-water mark in the tail-race to the west bank. At the present time the power-house is well under way, the excavation having been completed and the concrete work being well along. It is expected that this plant will be in operation on or about December 1, 1907.

The current from this plant will furnish light, heat and power for the city of Spokane, the Inland Empire Company having a broad franchise in the city. It will also be used to develop the country through which the lines of the Inland Empire System operate, furnishing power as far south as Moscow and possibly farther. The Inland Empire Railway System owns other power sites which will be developed when the power from this development shall have been used. The work of construction is in direct charge of F. M. Sylvester, local manager for Sanderson & Porter.

Some Aspects of Modern Switchboard Engineering.[1]

By C. W. Stone

THERE is no branch of the electrical profession which is more important than that of designing switchboard apparatus.

The switchboard must be as near fool proof as possible. It must be so arranged that it will make it possible to operate the system at all times, and in case of trouble its relay devices must act in such a manner as to cut off the particular part which is defective with as little disturbance to the system as a whole as possible.

Too often an engineer in making his plans for a new generating station thinks he can place the switchboard in most any place, and arranges the rest of the apparatus in the best way without regard to the switchboard. This often results in making a very undesirable and special switchboard arrangement, involving long and complicated runs of cables from the machines.

What I am going to attempt to do tonight is to try and point out some of the undesirable features to avoid, and also explain why some of the things are done as they are. I will also try and bring out some of the principles entering into the design of the different devices used on a modern switchboard.

The subject will be divided and treated under the following heads:

Instruments and their use.

Direct-current switches and circuit-breakers.

Oil switches.

Relays, etc.

Materials of panels.

General arrangement of apparatus.

Any of the above subjects are of sufficient importance to be treated in a paper by itself, and therefore can only be treated in a very general way in the limited time at our disposal.

INSTRUMENTS.

Direct-Current Switchboards—For direct-current work the problem of what instruments to use and what not to use is comparatively simple.

For generators ammeters are always necessary, and voltmeters can either be furnished for the entire group of machines, using plug switches to connect them to any machines or the bus-bars, or one can be furnished for each machine.

Ammeters are usually furnished for each machine, and are used to indicate that the load is properly divided between them. It is not advisable to try and use only one ammeter and any form of switching device, as such an arrangement is not only bad from the operators' standpoint, but it always means a sacrifice of accuracy.

It is desirable to locate the shunts used with the ammeters as near the instruments as possible; thus avoiding the use of long leads which have to be made of large size.

Balance indicators, which are simply galvanometers with scales marked "high" and "low" with a central zero, are sometimes used to indicate whether the voltage is too high or too low when machines are being paralleled. These instruments are small and inexpensive, and are a very useful addition to the switchboard.

Recording wattmeters are desirable, but not necessary. If used, the best place is on the generator panels, as they are thus always run with a better load-factor. An accurate record can also be kept of the work done by each unit.

Total output instruments are always bad practice, although often recommended. If any increase in the capacity of the plant is made, all total output instruments must be changed and all the connections thereto. They must also operate under the most adverse conditions, as they are obliged to work under such a great range in load.

For the feeder circuits the question of what instruments to use is always determined by the existing conditions, but in general where any instruments are used, ammeters will answer all requirements.

Alternating-Current Instruments—The question of instruments for alternating-current work is much larger than that in direct-current work.

In the first place, as all alternating-current generators are rated on their current output in amperes, it is necessary to use ammeters to indicate the current output. The question of the number to use is determined by whether the system is a balanced one or not. In general it can be assumed that where generators are supplying a load made up entirely of rotating apparatus, such as rotary converters or motor-generators, the load will be balanced sufficiently well so that one am-

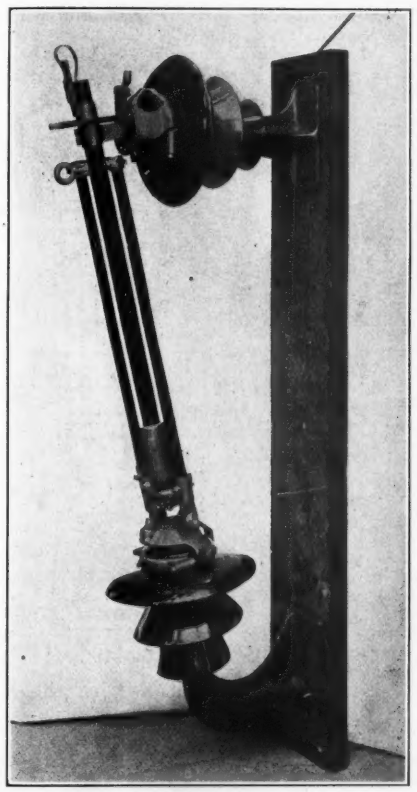
[1] Read before the New York Electrical Society, November 27, 1906.

meter will do. If the system is partly or entirely a lighting one, then three ammeters are needed for a three-phase generator, and two for a two-phase generator.

Unlike direct-current instruments, alternating-current ammeters do not indicate the division of load between machines at all, and it is therefore necessary to use some instrument which will.

Indicating wattmeters are most commonly used for this purpose and are practically indispensable.

Voltmeters can be used with each machine, or one can serve for the entire



EXPULSION FUSE, 60,000 VOLTS, 100 AMPERES.

group, using plug switches to connect them to any machine.

Another way would be to use two voltmeters, one connected permanently to the bus-bars, and the other used for the machine. This is a very good arrangement, as it makes it possible to compare the readings of the two, thus serving as a check on their calibration.

Field ammeters, while not absolutely necessary, are most valuable as a check in case of any trouble with the apparatus, and should generally be recommended.

Power-factor indicators used with generators serve no useful purpose, and may be very misleading. They are so constructed that any unbalancing of the circuit would be indicated as a change in power-factor, where no such change had taken place.

Indicating wattmeters are so constructed that if a power-factor indicator is wanted, a reversing switch in the potential circuit of the indicating wattmeter can be used, and the wattless component can be read; thus serving all practical purposes of a power-factor indicator.

There has been developed recently an instrument which is simply a polyphase indicating wattmeter; the scale being calibrated with a central zero, and indicates the wattless component either lagging or leading.

Frequency indicators are unnecessary, as after the plant is started and the governors of the prime movers once set the frequency is kept constant enough by them. If any are deemed advisable, one can be supplied connected to each set of bus-bars.

Since the introduction of turbine-driven machines, frequency indicators, calibrated to indicate speed, have been used quite extensively. These instruments are used in place of tachometers, and are mounted on the steam gauge board adjacent to the machine. On this same head board in large stations an indicating wattmeter is sometimes mounted, serving as a very useful guide to the steam engineer.

Integrating wattmeters are optional, and their use is determined by the local conditions. If it is desired to keep a record of the output of the station, it is better to use them on the generators.

Many different forms of synchronizers have been brought out. Synchronizing lamps were used for a long time, but are not as accurate as is desirable in large plants. If lamps are used, alone, it seems better to have them bright when machines are in synchronism. If they are so connected that they are dark, it is possible that in case of a broken filament in a lamp, synchronism may be indicated when machines are not in phase, with more or less disastrous results.

Dial synchronizers are now available which will indicate not only how far apart in phase machines are, but will also indicate whether the incoming machine is running too fast or too slow. These instruments should always be recommended.

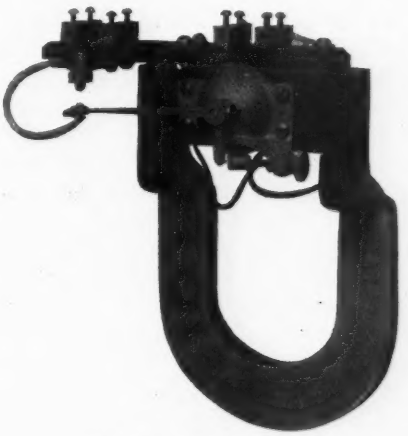
Automatic synchronizers are desirable in theory, but I have always felt that as they are more or less delicate in their construction, that it is unsafe to place entire reliance on them, as if there is any trouble, it may mean a complete shut-down and possible injury to the apparatus.

With any form of automatic device there is a tendency to rely on it more and more, particularly if it works well most of the time. This engenders carelessness on the part of the operators, and when the device does not operate correctly, serious trouble may result; particularly with the new high-speed apparatus.

For synchronous apparatus ammeters should always be used, as they serve as the best means of keeping the current input at normal.

Power-factor indicators are sometimes used for this purpose, but it is not safe to place entire dependence on them, as with any unbalancing of the circuits, wrong indications will result without the knowledge of the operators, and in the attempt to keep the power-factor at unity, the apparatus may be dangerously overloaded in current.

Lighting or power circuits can be taken care of by ammeters, unless feeder regu-



REVERSE CURRENT RELAY.

lators are used, when voltmeters must also be used connected on the feeder side of the regulators. The compensated type of instrument is preferable, as by its use, proper indication of the voltage of the feeder can be had without the necessity of any pressure wires.

Curve drawing instruments of different kinds have been developed, and are a very valuable asset where it is desired to keep a very accurate record of the output of any particular feeder or piece of apparatus.

There is one point that should always be remembered in connection with instruments, and that is that they should be so located that they are not subjected to the influence of any external magnetic fields, although the modern instruments made by the General Electric Company are shielded so as not to be greatly affected by stray fields.

DIRECT-CURRENT SWITCHES AND CIRCUIT-BREAKERS.

Lever switches for direct-current work are most commonly used for currents which are not of great magnitude, but are unwieldy and hard to operate when made of large capacity, such as 6,000 amperes and above. Laminated brush toggle switches are better suited to this work. Their construction is somewhat like that of circuit-breakers of large capacity.

Direct-current circuit-breakers have been developed of many types, to suit many different conditions of service.

Magnetic blow-out circuit-breakers are very commonly used, and I presume most of you are familiar with their construction.

Carbon-break circuit-breakers are best suited to large currents, and have been developed in many forms. They usually consist of a large brush to carry the main current, and some auxiliary contacts to take the burning at the time of opening.

Circuit-breakers should always be placed at the top of the board, so that they will be out of the way of the operator. Too often I have seen such breakers mounted low down on the panels; sometimes at the bottom, and when their location was criticised, the statement would be made that they were perfectly safe, as they had opened repeatedly without dangerous arcs. But sometimes a bad short-circuit may take place and the arc on the circuit-breaker may be very severe and thus do considerable damage to the board and possibly to the operator.

Enclosed fuses are often used, and while all right in small plants with small generator capacity back of them, are a source of considerable danger when used in large plants.

There are many other places where enclosed fuses could be safely used, such as at the end of long feeders at a considerable distance away from the source of power, and small branch circuits, etc. Circuit-breakers, however, as developed at present are very slightly more expensive in first cost, and of course the renewal expense is much less. They occupy very little more space, and of course can be reset much quicker than a new fuse can be put in place, and if properly located, cause no trouble when opened under short-circuits.

OIL SWITCHES.

Oil switches were designed to meet the demand which was created by the advent of the alternating-current system of high voltage. The first attempts were more or less crude, and the theory of their operation was very imperfectly understood. Since their introduction, however, tremendous strides have been made, and the oil switches of to-day are a very necessary piece of apparatus, and have made possible the successful operation of long high-tension systems for the distribution of power.

The first oil switches were nothing more nor less than a small knife-switch enclosed in a tank containing oil. How much oil to use, the distance beneath the oil that the contacts should be placed, the amount of air space, if any, to allow above the oil, have all been figured out by a long system of careful tests, so that the best proportions for the switch and the best form of contacts, etc., are now pretty well settled.

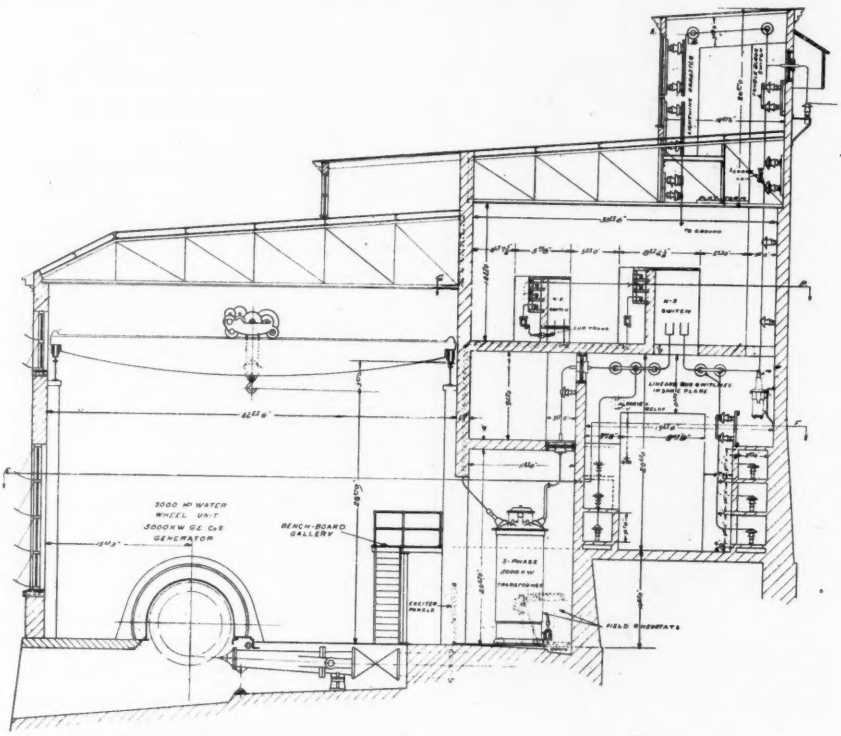
It is not safe to depend on any type of oil switch, the design of which seems theoretically correct, unless it has been subjected to very exhaustive tests repeated many times.

A switch which is designed to occupy small space, and to be comparatively cheap, can not safely be used in stations of large capacity and at high voltages.

I will not take up your time by entering into a description of all the forms of oil switches which are now used, but will simply try and describe two types.

The K-3 switch which is manufactured by the General Electric Company is made single, double, triple and four-pole, single and double throw, in different capacities.

The operating mechanism and the contacts and the contact rods, etc., are all carried on a top casting. Through this casting the contact rods are carried through porcelain insulators. These contacts are enclosed in an outside tank which is filled with oil; barriers being placed between the different poles. Contact yokes are carried on the end of wooden rods, which are attached to the operating mechanism. The movement of the handle raises or lowers these contact pieces, bringing them, when raised, into contact with the contact blocks, and when lowered are separated therefrom.

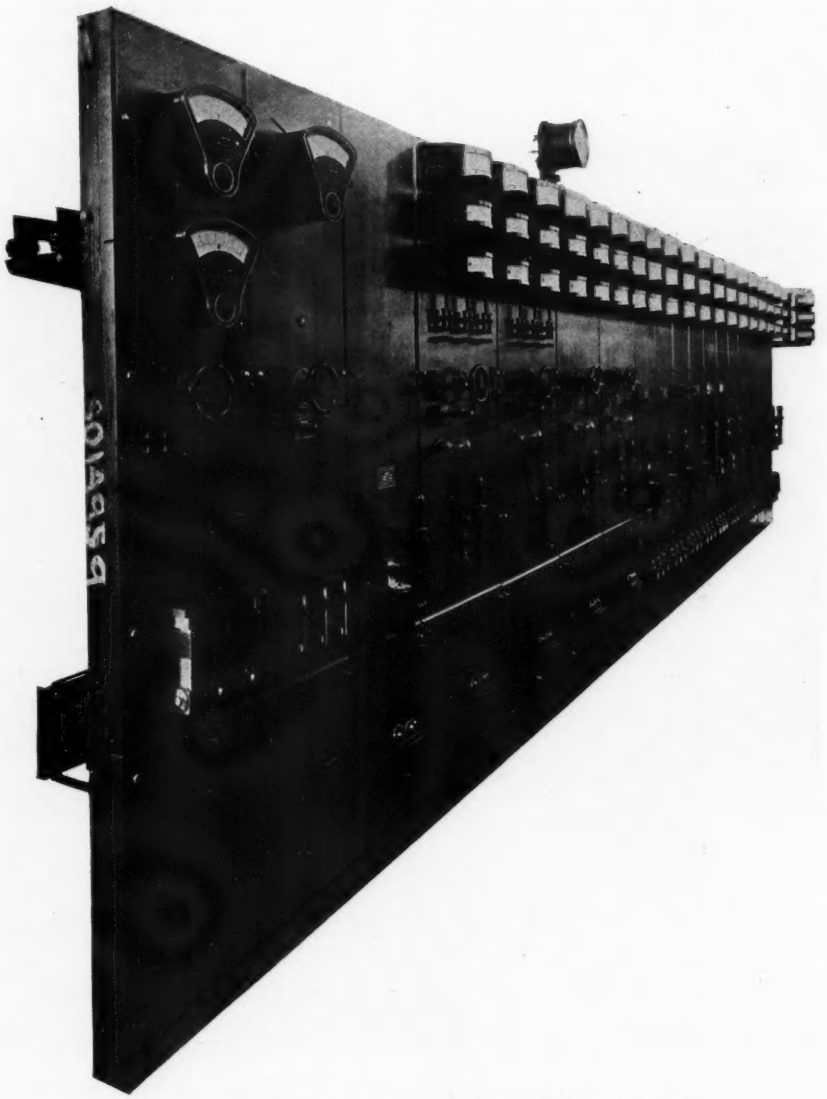


SECTION OF 60,000-VOLT GENERATING STATION FOR STANISLAUS ELECTRIC POWER COMPANY, CALIFORNIA.

Most of the oil switches, with the exception of those of very large capacity, are modifications of this design, and the general theory of their construction and operation is exactly the same. As explained above, the proportion of the parts, the amount of oil to use, etc., have been determined by a long series of experiments carried to the point of break-down of the switch. These tests are made by using large capacity alternating-current generators, and short-circuiting them, and opening this short-circuit instantaneously by means of the oil switch. At the time of opening, oscillograph records are taken to show the amount of current and the potential of the circuit when opened. No tests which are made using small capacity

generators with transformers in circuit can be relied on. Nor is it possible to fix the limit of the switch by a single test, as I have seen repeated short-circuits opened successfully by means of a switch, and then one other test under exactly similar conditions destroying the switch.

Indications tend to show that the oil switch when opening opens on the low point of the wave, or practically zero current, and for this reason has a tremendous advantage over any switch opening in the air.



Alternating-Current and Direct-Current Switchboard.

The opening of an arc in the air of an alternating-current system is apt to cause dangerous rises in voltage, by causing surging of the system. The oil switch, however, opening on the low point of the wave, as a rule can be depended upon to cause no such disturbance.

The K-3 double-throw switch is made by having practically two switches complete inside of one oil vessel; the centre contact rod having two contacts at its lower extremity, and the two outside rods having a single contact. The contact yoke pieces make contact across one of the middle contacts, and one of the outer contacts, according to which handle of the switch is operated. The two handles are interlocked, so that it is impossible to operate both of them at once.

When large systems employing a large number of machines of great capacity were first being discussed, it was felt that switches of the character just described would not be safe to open the circuit in cases of overloads and short-circuits. A switch of totally different design was therefore developed. This switch was operated by means of compressed air. Each pole of the switch was made up of two cylindrical oil vessels, in the bottom of which was placed a contact. These oil vessels were carried on large insulators placed in the base of a switch compartment. The two elements of each phase were separated from the other phases by means of brick or soapstone barriers. Passing through the top of the two oil vessels of each phase were two contact rods which were carried on a yoke. This yoke was fastened to the operating mechanism by means of a long wooden rod. The connections to and from this switch are made to studs passing through the insulators which support the oil vessels. You will thus see that the operation of this switch is exactly opposite to that which was used with the K type of switch, as in this case the contact rods are pulled up from the contacts, while in the K type of switch the contact rods are dropped away from the contacts.

Since the development of this switch, the operating mechanism has been changed a number of times, and the latest development is a motor mechanism, with which you are probably all more or less acquainted.

The contact arrangement is essentially the same, although many improvements have been made in the small details. One of the latest and best improvements is in making the oil vessels of pressed steel. The original vessel was made of a seamless brass pipe. In the bottom of this pipe a bottom carrying the contact was soldered, and the top was threaded to receive the cap. The new type of vessel is made of steel; the top being put on in the same way as on the brass pipe.

The motor mechanism has very many advantages. It of course is simpler than the compressed-air switches, in that it is not necessary to use any air-compressors, and there is not the trouble due to sticking valves and similar troubles. It is much better than any solenoid arrangement, as a motor can be worked through a much greater range of voltage, and the currents necessary to be carried on the controlling circuits are very much less than they would be if a solenoid were used. The tripping of the switch is entirely independent of the motor, as the action of the switch is such that the motor carries the crank of the mechanism slightly past centre, where it is held in position by a small toggle. This toggle is opened by means of a small electric magnet. There is a still further advantage in that the operation of the switch is much quicker.

There is one very distinct advantage in using a switch of this kind for stations of large capacity, and that is on account of the design of the oil vessels, etc., it is

possible to use the minimum amount of oil, and it is also possible to use what we call bafflers, which are placed inside the oil tank around the contact rod. These bafflers consist of small plates of pressed board with different size apertures, according to the capacity of the switch. Their action is as follows: on the opening of a contact under oil, a great pressure is generated, which tends to throw the entire body of oil above the contacts in an upward direction. If the vessel were oil tight and no air chamber existed above, it would be practically impossible to build a tank which would not burst at such a time. The top of the oil vessel is, therefore, made more or less open, and a considerable space is allowed above the level of the oil inside the oil vessel, which acts as an air cushion. The bafflers tend to break up the oil, so that it is not thrown up as a solid mass. Repeated experiments with accurate measuring instruments have indicated the proper size of aperture in these bafflers.

Oil switches such as just described are in use by all the large operating companies all over the world, and are made in all capacities, and are in successful use on voltages up to and including 60,000 volts.

The 60,000-volt switch is made on the same general lines as the lower voltage switches, the method of making the oil pots and their mounting and the space occupied being the only difference. The oil pots in these switches, instead of being of metal, are made of wooden staves, something like a barrel, and are held together by wrappings of cord. These pots are mounted on insulating standards.

With large switches of this type it is advisable to use knife-disconnecting switches in series; thus making it possible to isolate the switch for inspection and repair.

The smaller type, or K type of oil switch as we call it, is operated in a number of different ways. Unlike the large H switch, the moving member is small and light, and only has to move through a very small distance, and therefore can be successfully handled by means of a solenoid. The solenoid mechanisms have therefore been developed for all.

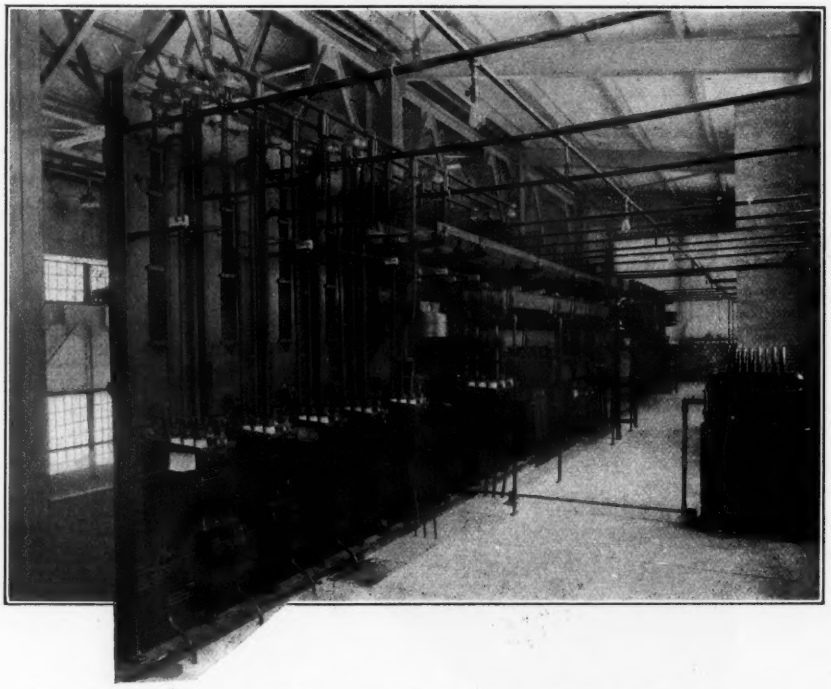
MATERIALS OF PANELS.

A number of different materials have been used for panels carrying the instruments and switches; the principal ones of which are slate and marble. Slate has been finished in a number of different ways; in some cases black enameled; in other cases it has been marbleized; in other cases it has been finished with a dull black paint, but the best finish seems to be to take a fine quality of black slate, and finish it with a smooth dull finish and then oil it. This makes practically an indestructible finish, and in case of scratches simply rubbing over the finish with a little oily waste will remove it.

Different kinds of marble have been used, such as pink Tennessee, white Italian marble, white Vermont marble and blue Vermont marble. Pink Tennessee marble is difficult to get in large quantities, and varies so in color that it is very difficult to match the different panels. White marble, either of the Italian or Vermont quality, is very easily discolored, particularly by oil. Blue Vermont marble, however, being of a slightly darker color, does not show stains as quickly as white marble, and can be obtained in large quantities. This marble, while it varies greatly in its general markings and in its general color, can be very readily matched, so that when a complete switchboard is ordered it is possible to look over the stock and pick out panels which will match sufficiently close to give a good general appearance.

Marble is not as necessary for high-tension switchboards as formerly, as with the oil switches no dependence is placed on the marble for insulation.

The question is often raised as to how to remove oil stains from marble. There is no good way that I have ever heard of for removing oil stains which are of long standing. However, it is possible if the stains are comparatively new to remove them by several different methods. One method is to use a blow torch, but this is a very careful operation, as unless carefully used the marble is very liable to crack. Another method is to cover over the portion of the marble which is stained with a preparation of plaster of paris, allowing this plaster of paris to harden. It will then absorb during this process most of the oil. This process can be repeated several times if necessary. Another method is to saturate the panels with oil in the first place, thus they will not show any stains. This method, however, is thought objectionable by some people, on account of the rather dirty gray appearance of the marble.



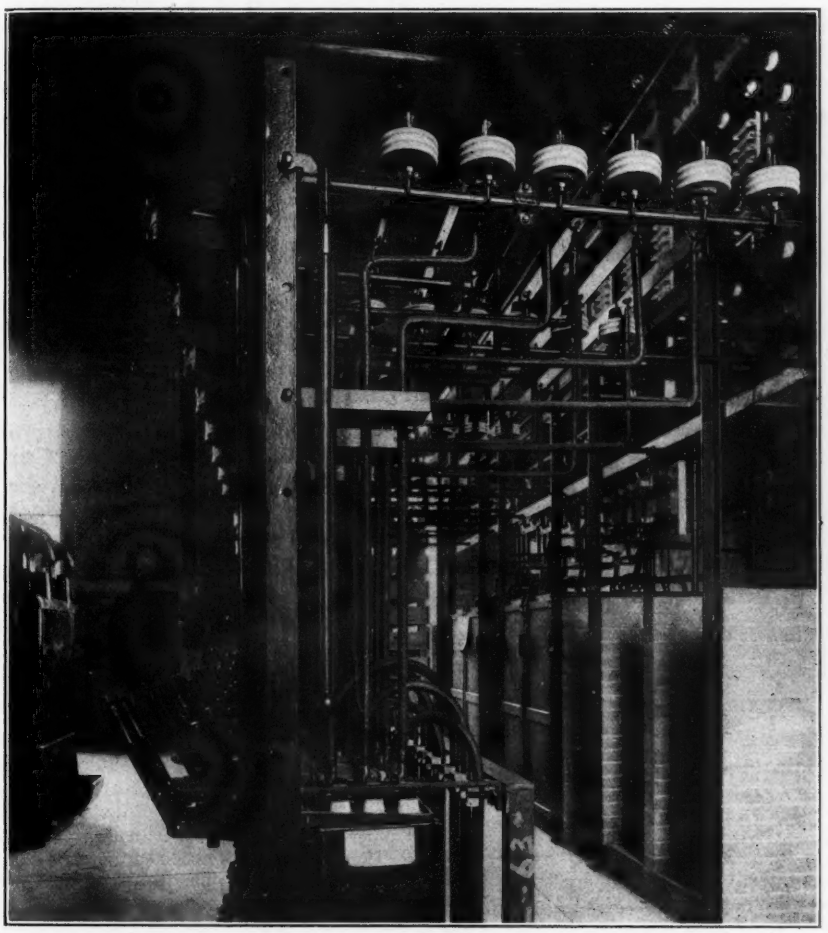
REAR VIEW OF SWITCHBOARD IN POWER-HOUSE OF THE CALUMET & HECLA MINE, CALUMET, MICH.

RELAYS, ETC.

In direct-current practice the only relays which are used to any great extent are straight overload relays, which are usually made a part of the direct-current circuit-breakers. For special work, such as storage battery work, an underload relay is often required; this relay simply opening the circuit when the current has dropped below a certain value.

Reverse-current relays for direct-current work are considered necessary when storage batteries are used in connection with motor-generator sets and rotary-converter sets, in order that in case of trouble on the high-tension side of the system the storage batteries will not feed back through the rotary-converters or motor-generator

sets. These relays are very simple in construction, consisting simply of a horse-shoe frame of iron which is placed around the stud of the circuit-breakers. The ends of this horse-shoe frame are equipped with pole-pieces, between which is placed a shuttle armature with a single winding. This winding is connected across the bus-bars. Thus with any current flowing through the stud of the circuit-breaker, the armature tends to rotate in a certain direction. A stop, however, is provided to prevent movement beyond a certain point. If the current reverses naturally the armature of this relay would tend to revolve in the opposite direction. Contacts are provided so that in case movement in this direction takes place, contacts will be closed, and will close a circuit through a shunt trip coil provided on the circuit-breaker, or in some cases will short circuit a no-voltage coil which is placed on the circuit-breaker.



SIDE VIEW OF SWITCHBOARD IN POWER-HOUSE OF THE CALUMET & HECLA MINE, CALUMET, MICH.

For alternating-current work a number of different types of relays are in use; the overload relay which has been generally used consisting of a simple solenoid and a set of contacts, so arranged that the movement of the plunger in the solenoid will either close or open the contacts. Where it is possible to obtain direct current for the tripping of the different circuit-breakers, the type of relay usually used is the one which has the contacts normally opened. In substation practice it is frequently impossible to obtain any constant source of power to do the actual work of tripping the devices. In cases of this kind contacts on the relay are usually reversed, and current from the current transformers is used for tripping the circuit-breakers. Under normal operation the trip coil will be short circuited by contacts, but in case of overload the contacts would open; thus sending the alternating current through the trip coil of the circuit-breaker.

These relays are made both for instantaneous operation and with time-limit arrangements. The best type of time-limit arrangement to use in most cases is one which has been developed in the last few years, which consists of a simple bellows placed above the contacts and fastened to the plunger. This bellows is provided with a small valve at the top, the opening of which can be adjusted so that the relay can be set for any desired time. With a relay of this type the time element is dependent upon the amount of current flowing through the solenoid, and is practically directly proportionate to this current. Thus if set for a certain time with a certain current, if the current is double, the relay will open in practically half the time, and in cases of short circuit it becomes practically instantaneous.

Another type of time-limit relay is the definite type which is made in two ways. One is the bellows type, which is very similar to the inverse time-element type; the only difference being that the plunger is not rigidly connected to the bellows, and has a spring interposed in such a manner as to make the pressure on the bellows constant whenever the relay operates. The other form is a clock-work mechanism, which consists simply of an ordinary clock mechanism which revolves a fan, the blades of which can be adjusted so as to obtain a predetermined time of operation. This clock mechanism is released by a simple electromagnet connected to the series transformers in the circuit.

There have been no reverse-current relays developed for use on alternating currents which can be depended upon at all times. Many different types have been brought out, which under certain circumstances operate very satisfactorily, and before any are recommended, the operating conditions should be very carefully studied, and the type to use determined after this investigation.

GENERAL ARRANGEMENT OF APPARATUS.

The general arrangement of switchboards and switchboard apparatus is of necessity more or less determined by the local conditions.

The general dimensions of panels have been more or less standard for a number of years: The height being ninety inches and the panel being divided into two sections, the lower section of the General Electric Company panels being twenty-eight inches and the Westinghouse Company being twenty-five inches.

All switchboards are laid out with the idea of using standard height panels, and by making many different arrangements of instruments and switches, it made it possible to determine on the best locations of the different devices on the panel. By so doing, any standard panel for any machine or feeder can be added to the switchboard, and one can be sure that all the devices will line up. All instruments

should be so placed as to be easily reached by the attendant, and also high enough on the panel so that they will not be readily injured.

All operating devices should be mounted beneath the instruments, except the direct-current circuit-breakers, which as stated above should be at the top of the panel and should be so constructed that they can be readily operated when in this position.

The location of the bus-bars and connections can not always be the same, but

Fifty-Cycle, Alternating-Current Controlling and Instrument Switchboard for Necaxa, Mexico.

on direct-current switchboards it is much better to place them in back and at the top of the panels. Sometimes this will mean some extra copper, but on the other hand the back of the board is very much more accessible, and the chances of short circuits on the buses are much less. Great attention should be paid to making the back of the panels as simple and as open as possible.

High-tension alternating-current switchboards for medium voltages and for medium capacity stations should have the buses mounted at the top and in back of the board, or in some cases beneath the floor, and the oil switches mounted directly on the panel or preferably on a pipe framework at a considerable distance back of the panels. As the potential increases and the capacity of stations increase, extraordinary precautions must be taken to prevent any trouble, and to confine any trouble. Switches should be mounted in brick compartments, and at 10,000 volts or above, the switches should be made up of single-pole elements, and each pole kept in a separate compartment. The bus-bars should also be placed in brick or concrete compartments, keeping each phase separate from the others.

Some engineers seem to prefer the end of the station for the switchboard, but this is about the worst place that can be chosen. One can never tell to what size the station may grow, and consequently may find that later it will be necessary to move the entire switchboard to some other place, which is not only expensive, but it is also difficult when the board must be alive at all times.

I think that in the majority of cases it will be found that all things considered, it will be best to locate the board along the wall opposite the boiler room, avoiding galleries as much as possible. Many galleries always mean long and expensive runs of cable and controlling circuits, and in consequence increases the chances of trouble. If the feeders go out below the switches can be placed on the main floor and the bus-bars and compartments placed in the basement. If it is not possible to get the buses in the basement it is possible to build one gallery for the switches, and place the buses on the main floor. A number of stations have been built recently with all the switching devices in a separate house. This has numerous advantages. The switchboard men are not disturbed by any unusual sounds, and in case of trouble in the engine room such as a broken steam main, would not cause them to become confused, and make wrong moves. All the necessary orders can be transmitted, either by signal devices or by telephone. A separate switch house of course is not desirable, except in very large stations.

No matter what arrangement is decided upon you should always keep in mind that simplicity means that troubles become less. Do not provide some automatic protection if it is possible by changing your arrangement to dispense with it. Flexibility is a good thing to have, but the more flexible you make your switchboard the more complex it becomes, and then automatic devices become necessary. And after they are put in it is found that to assure their accurate operation others must be put in.

Apparatus for Wireless Control of Mechanisms.

In a note presented before the French Academy of Sciences some details of a receiving device for controlling, by means of electrical waves, mechanisms at a distance are given. This consists of a hollow wheel divided into four or more segments, as may be desired. Three or more of these segments, as the case may be, carry a small glass tube bent in such a way as to retard the motion of a globule of mercury contained within it. At the outer end of this tube are two contacts connected to corresponding slip rings on the axle of the wheel. The method of control consists in sending out trains of electric waves. Each train moves forward the controlling wheel through one segment. As each segment comes into the lower position the globule of mercury begins to move slowly down the tube toward the two contacts. If the wheel remains in that position long enough, contact will be made, and thus a local circuit on the controlled mechanism closed. If, however, the wheel moves forward another segment the movement of the mercury globule will cease, due to its changed position; and the same action will begin in the following segment. Thus, by sending out one, two, three or more impulses, a corresponding segment can be brought into that position in which the local circuit will be closed. No other circuits are closed, because the wheel is moved forward before the mercury can reach the contacts.—*Translated and abstracted from L'Industrie Électrique (Paris), February* 10.

Electrical Notes from Europe.

(By Our Special Correspondent.)

A CENTRAL STATION of considerable size is to be erected in order to give an additional supply of current for the city of Rome, and it will rank among the large central plants of Italy. Seeing that the hydraulic power of the falls at Tivoli is already used, the present plant will be run by steam, and will have a large boiler house and dynamo room laid out on modern principles. The total cost of installing the present station is estimated at nearly one million dollars, this for a capacity which will be near 3,000 kilowatts. Later on the plant will no doubt be increased in capacity and will be able to give 10,000 kilowatts. In this case the total cost will be about $3,000,000.

Electrolytic preparation of zinc plates for storage batteries is the subject of a recent German patent. The process relates to porous zinc plates which are used in batteries with a constant alkaline bath. The inventors recognize that zinc plates which are obtained by the reduction of a paste of zinc oxide or carbonate are not of great value in practice, seeing that the greater part of the mass falls off at the time of the reduction, and besides the method of preparing the plates is somewhat complicated. In the new process these disadvantages are overcome by using a liquid consisting of zinc dissolved in hydrofluoric acid. From this liquid the zinc is deposited upon suitable supports having the shape of the battery plate. In this case the zinc is deposited in a porous state, but is relatively solid and not spongy and adheres well to the support. The activity of the zinc thus prepared is considerable, and it oxidizes quite readily in the air. For making the battery cell they use negative electrodes made of the zinc plates in connection with positive electrodes of copper or nickel. The electrolyte, carbonate of ammonia, for instance, does not attack either of the plates.

One of the new metallic filament lamps which has been brought out in Germany recently is the Osram lamp, and it is manufactured by the Gasgluhlicht Company of Berlin. This company is satisfied at present with the performance of the lamp and intends to place it upon the market in large quantities. It is designed to run upon 110 volts and equally well with direct or alternating current. A number of these lamps were given a test at the Reichsanstalt not long ago, and showed very favorable results. The mean consumption is near one watt per candle-power, and the lamp holds up well for a thousand hours, without much decrease in the efficiency. A sample figure taken from the tests at zero and at 1,000 hours is as follows: At the start, 117 volts, 0.272 amperes, 28.5 mean horizontal candle-power and 1.11 watts per candle. After 1,000 hours, we find 117 volts, 0.269 amperes, 26.6 candle-power and 1.18 watts per candle.

At the last Paris Automobile Show there were several electric automobiles which presented considerable interest. Among these is the "Electromotion" car, which is brought out by a Paris firm. What characterizes it is that the motor is built into the rear wheel and forms, in fact, the hub, somewhat resembling the German Lohner-Porsche system which was described some time ago. In the "Electromotion" system the field is fixed upon the end of the axle and the armature placed around it, in ring form. From the armature casting there are ten radial spokes which hold the wheel rim. The interior field of the motor consists of ten poles fixed upon an internal ring and the latter fits upon the end of the axle. A cast-steel ring contains the external armature, and this part is enclosed by an aluminum cover. It is to be noted that the collector lies near the armature windings and is in consequence of drum form and has a large diameter. The brushes are placed next the centre of the motor and bear upon the inner periphery of the commutator. About eighty volts, from the storage battery of the car, is used to run the motors, and the speed of the latter is near 130 revolutions per minute. The two motors of the car are permanently connected in series and the field windings are made in sections, with the ends brought to the controller so as to provide for the different speeds. As to the controller, it is reduced to a very small fixed drum about six inches in diameter, with pairs of brushes turning about it, and contained in an aluminum case.

F. Braun, the German inventor, has secured a patent in that country for a wave-detector on a new principle. Certain bodies do not follow the usual law of resistance, such as metallic sulphides, pyrolusite, and others. The inventor finds that the mineral psilomelan, a manganese ore, has the greatest effect of this kind, and it also shows a conductivity for the current in only one direction. Used as a detector for electric waves, it did not seem as sensitive as the electrolytic detector at first, but was afterwards improved so as to be nearly equal to it. The detector which he uses is of very simple construction. It consists of a piece of the mineral fixed in a cylinder of cast tin and the latter is placed at the end of a brass tube. Screwed into the tube is an ebonite stopper which carries an iron screw. By screwing down the latter from the outside contact is made between its inner end and the surface of the mineral, upon a surface of about one square millimetre. In this case 0.5 to 1.0 volt is used in the local circuit with the relay or telephone. As the resistance of the detector is very high, it might cause a damping of the oscillations in the receiver or in a resonance circuit, therefore as in the case of the electrolytic detector it is placed in a resonance circuit having a portion of its self-induction placed in parallel with the detector. Even though the damping is increased by the addition of a high ohmic resistance here, the general result is very good.

The Pirelli firm of Italy is manufacturing a cable which is to be used for 100,000-volt circuits. It is constructed in the following way: The core of the cable is covered with a lead sheathing, then comes a layer of rubber about 2.5 millimetres thick and two other layers of rubber 2.3 and 4.5 millimetres thick respectively. The latter is covered with a layer of impregnated paper of 5.2 millimetres thickness. Lastly comes a layer of hemp and a lead sheathing, which completes the electrical and mechanical covering. The thickness of all the insulating layers is fifteen millimetres and the outer diameter of the cable is sixty millimetres.

At the Krupp works in Germany is being built an electric furnace of the Gin type. It works on the induction principle and has a rectangular form, with canals placed parallel to each other and inclined. The canals are connected by conduits of semicircular section known as heating conduits, which put the end of one canal in connection with the beginning of the next. A copper bar winding around the whole is used as the primary, while the fused metal forms the secondary. The primary copper is cooled by an air fan. The furnace is designed so as to give the best fusion and circulation in the melted metal. C. L. DURAND.

Paris, February 23.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

Method of Determining the Efficiency of Continuous-Current Dynamos.

A method is described here by P. Soulairol for determining the efficiency of dynamos and motors under conditions of actual test, but which does not involve the measuring of any mechanical quantities. The method consists in operating the machine first as a generator and then as a motor under conditions as nearly the same as possible—that is to say, if it be a generator, the speed and the current in the armature are noted, and then the dynamo is run as a motor at that speed and voltage with the same current in the armature. Under these conditions the iron and friction losses, the copper losses, and the armature reactions and the counter-electromotive-force will be the same. Equations may then be constructed involving these relations, which will enable the internal losses of the machine to be determined. Knowing this, the efficiency is, of course, easily computed. The method of procedure should be varied somewhat, according to the character of the service which the machine is to give. For example, if it is a separately excited generator or motor, the exciting current will, of course, be constant. If it is a constant-potential generator, the terminal voltage must be maintained constant; while if it is a motor, the voltage of the supply will be fixed. These varying conditions change slightly the intermediate equations, but the final equation for the efficiency in each case is the same. The method may be applied to determine the efficiency under any and all conditions.—*Translated and abstracted from L'Éclairage Électrique* (*Paris*), *February* 9.

The Regulation of Power-Factor.

The question of compensating for the low power-factor of a supply system, brought about by the use of large numbers of induction motors, has come up before the Sheffield (England) Corporation electric supply department. The power-factor at the present time is about sixty-five per cent. The engineer for the company has issued specifications which contemplate raising the power-factor to about ninety per cent by means of over-excited synchronous machines. The conditions call for separate sets of apparatus, one to be installed in a substation at the principal centre of distribution for power, and another in the generating station on Sheaf street. The first-named set of machines will have to compensate for the drop in the feeders so far as it is due to lighting currents. The second set is required to improve the power-factor, and thus assist in regulating the generators and increasing their available output. The method of compensating suggested is the use of so-called rotary condensers. Each set is to have an output of 600 kilovolt-amperes, and must be able to increase the power-factor, as mentioned above. Although the specifications do not give the load on the system, the contractor is required to state with what load on the generators the machines offered may be used successfully. The real problem apparently is to design a machine which will give the maximum leading current for its size and internal losses. This calls for a high armature reaction, low internal resistance and large exciting current.—*Abstracted from Electrical Engineering* (*London*), *February* 14.

A New Method of Telegraphing Pictures.

Recent modifications of his method of telegraphing pictures, described several years ago, are given here by A. Korn. The original system had two defects: the intensity of the beam of light at the receiving end was too low, so that the time required for sending the picture was long; and, secondly, the selenium cell was sluggish. This also retarded the speed of transmission. The new system has resulted from efforts to eliminate these objections. The sending apparatus is practically the same as that formerly employed, the picture to be sent consisting of a transparent negative which is wrapped around a cylinder of glass. This cylinder is, however, placed vertically instead of horizontally. The beam of light, after passing through the negative, is reflected, by means of a prism, upon the selenium cell. The motion of the negative past the beam of light, which comes from a Nernst filament, is about one millimetre for each revolution. The current is drawn from a storage battery. The modifications of this system have been made at the receiving station. The line current passes through two fine copper wires stretched between the poles of a permanent magnet. Across these two wires is placed a small, thin aluminum sheet, which acts as the shutter to an opening in a suitable diaphragm. Upon this little shutter is concentrated the light from a Nernst filament. As the line current is varied by the variation in resistance of the transmitting selenium cell, this little shutter moves aside more or less, and thus allows more or less light to pass through the opening in the diaphragm, whence it is concentrated, by means of a lens, and thrown into the receiving box, falling upon the sensitive surface. In this way a sufficient intensity of the beam of light is obtained. To compensate for the sluggishness of the selenium cell, a second selenium cell is placed in a shunted circuit to the receiving device. There is also in this circuit a second receiver similar to that which regulates the amount of light thrown upon the sensitive surface, but this receiver varies the amount of light which falls upon the local selenium cell. There is in this shunt circuit a second storage battery. The variations in this local circuit therefore correspond to the variations in the line current, and in this way the lagging of the first cell is compensated for. Synchronism is obtained by means of a contact upon the receiving cylinder of the transmitting station, which sends an impulse through the line and thus releases a catch on the revolving receiving drum. —*Translated and abstracted from Physikalische Zeitschrift* (*Leipsic*), *February* 15.

Measurement of the Hysteretic Loss at Slow Cycles.

A method of determining the hysteresis loss at slow cycles, which may be carried out by a single observer, is described here by Dr. Gisbert Kapp. It consists in passing through the transformer winding, or preferably through two windings connected in series, so that their magnetic effects will additive, a current supplied at a constant potential from a storage battery. This current is reversed suddenly, and by means of a stop watch readings are taken of the current values for different

time intervals. To obtain these readings accurately the process must be repeated successively, as the current changes rapidly at first; but as it gradually builds up the magnetization it changes more slowly and readings can be taken at successive intervals. In this way a curve is obtained, and the area included between this and the time axis represents the losses in the transformer and the energy stored up in the magnetic field. This must be corrected for the copper loss, which is easily done graphically. The new curve crosses the other at that point at which the latter crosses the time axis. The area included between these two lines is then measured by means of a planimeter, that part of the line lying between zero time and the point at which the two curves cross being counted negative. The resulting area, multiplied by the applied voltage, is equal to the watt-seconds used up in iron losses during one-half cycle. By varying the applied voltage the exciting current may be varied and the hysteresis loss at different maximum inductions be obtained.—*Abstracted from the Electrical Engineer (London), February 15.*

The Continuous Production of High-Frequency Oscillations.

A résumé is given here by R. A. Fessenden of his many efforts to obtain continuous high-frequency electrical oscillations for use in wireless telegraphy. The author apparently has tried many methods, including those of Thomson, Cooper Hewitt, Duddell and others, but found that none of these gave sufficient uniformity of frequency to be of practical value. The method suggested recently by S. G. Brown, in which a metal disc is revolved while in contact with the conducting brush, is simple and has been used by the author in modified form. Instead of allowing the brush to press upon the revolving disc, a gap of about one-thousandth of an inch is maintained between the brush and the aluminum disc. This gives a steadier frequency. Good results were obtained by making the disc rotate synchronously with the frequency. A spark-gap in compressed air has been experimented with considerably. It was found that in the first method, in which the bottom of the containing vessel formed one electrode, that the results were decidedly better than when independent electrodes were introduced. The advantage was that in the former case the cooling action upon the electrodes was much superior. The sides of the vessel were then made of exceedingly thin metal, only a few thousandths of an inch thick, which was just sufficient to withstand the pressure of the gas within when, at the same time, streams of water were directed against the outer surface of these thin sheets. By this means the electrodes are kept cool, there is no volatilization of the metal, and the discharge is carried entirely by the gas. It was found necessary to vary the metal for the electrodes with the gas employed. Aluminum is better when using hydrogen, while silver and copper are more suitable when the gas is oxygen or nitrogen. In order to make the frequency absolutely constant, an oscillatory circuit having a definite natural or artificial period is arranged operatively to the sending conductor, in such a way as to govern the frequency of the discharge. In one arrangement there are three spark-gaps, and the oscillatory circuit is connected to the aerial and across the middle spark-gap, and is adjusted so that it governs the time of breaking down the gap. The method finally adopted thus consists of an arc between paper-thin, water-cooled electrodes in compressed nitrogen, in conjunction with a governing circuit of solid electrodes of special alloys or of special gases. The antenna itself may be used as the capacity without any local tuned oscillatory circuit excepting the governing circuit.—*Abstracted from the Electrician (London), February 15.*

The Standard Specification for Carbon Glow Lamps.

The recently proposed standards for carbon incandescent lamps, as defined in a paper presented before the Institution of Electrical Engineers, of Great Britain, are criticized here by L. W. Wild. Objection is made to the proposed method of testing the insulation of the bases. The time during which the difference of potential is applied should be given, since the resistance is found to change rapidly, due to the leakage of current. Although a test for vacuum is called for, no details are given in the specifications, the method apparently being left to the manufacturer. This being the case, it would be better to omit this test. The rating of the lamps is to be determined by testing five per cent of them, and ninety per cent of the tested lamps are required to fall within certain limits, which are held to be reasonable; but it is thought that if the manufacturers adhere to this a large part of their output will be useless. A life test is called for of never less than five lamps, to be run on a pressure varying not more than one-half per cent. The lamps are to be started at a standard energy consumption. This method is reasonable in one way, but the results are unsatisfactory, because the candle-power is allowed to fall to eighty per cent of the standard value, so that a lamp starting at a candle-power a little above the standard will be allowed to run a considerably longer time than one starting at or just below the standard. The first, of course, will be given an unjust rating. The specifications also rate the lamps by their mean horizontal candle-power, rather than their mean spherical, or true, candle-power. On account of this the consumption of the lamps will be assumed different from what it should, so that the filaments will not be subjected to the same conditions during the life test. These two sources of error may result in giving one lamp a life three times that of another when it does not deserve it. The best method of making the life test is thought to be running for 500 hours, making tests for mean spherical candle-power at the start and at the end of every 100 hours. These results are to be averaged and the average is not to be less than a certain limit. It is a question whether the lamps should be started at their standard energy consumption, as called for, or at their marked voltage. The former is the better plan, if it is the object to determine the quality of the filament only, but the latter is the better when lamps are being compared. To determine the mean spherical efficiency there are several methods. The one probably most used is to determine the mean horizontal candle-power, and by means of a spherical reduction factor to compute the mean spherical candle-power. The author prefers measuring the maximum horizontal candle-power, which is obtained by two measurements taken on opposite sides of the lamp, and multiplying this by a reduction factor which is practically independent of the shape of the filament, and varies only between 0.805 and 0.825.—*Abstracted from the Electrical Review (London), February 15.*

Secretary Taft will, it is said, appoint a committee, consisting of Charles F. McKim, the architect; Frederick L. Olmstead, Jr., of Boston, landscape gardener, and Frank D. Millett, the artist, to go to Niagara and gather material for a report looking toward harmonizing the commercial buildings there, particularly the power plants, with the natural scenery.

Methods of Getting New Business

A DEPARTMENT DEVOTED to the COMMERCIAL DEVELOPMENT of CENTRAL STATIONS

Managers are Invited to Contribute Suggestions for Methods of Increasing the Demand for Electric Service

EDITED BY CHARLES A. PARKER.

The Hard-Hitting Follow-Up Letter.

Perhaps no other form of advertising partakes quite so genuinely of the "personal ring" as the facsimile typewritten follow-up letter. And the reason of this presents no unsolvable mystery.

In days not long gone by the imitation typewritten form letter was little better than a mirthful, or a serious, joke—according to the viewpoint taken. Its cheapness of imitation, its impotent effort to counterfeit, stood out palpably enough to defeat its original intention and very purpose. It suggested, somewhat, a stage hand beating his iron thunder sheet in full view of the audience, blissfully ignorant in his belief that the storm scene would appear realistic to the audience. But it didn't. The visible mechanical trickery of the stage spoiled the effect of the scene, just as the evident weak attempt of some follow-up letters to imitate the actual typewritten letters, render themselves silly, self-convicted impostors.

MR. DRYGOODSMAN,
City.

DEAR SIR:

What's all this fuss about a sign?

If it's a painted sign, nobody tries to notice it in the daytime, and nobody can after dark.

Consequently it's a hollow mockery.

Put up an Electric Sign, and nobody will have to try to notice it.

It will take the place of your painted sign in the daytime, and at night it will shine forth with a magnificence that nobody can miss.

It will fairly startle folks and hold their attention.

It will impress them.

It will make them familiar with your store and its exact location.

It will naturally make them associate your store with your Electric Sign, to the extent that they will refer to yours as the "Store with the Electric Sign," and also often refer to it as an object point in locating other stores on the street.

Do you imagine such advertising would help you?

May we call for the answer?

Yours truly,
JOHN DOE LIGHT AND POWER CO.

SPECIMEN LETTER No. 1.

Once upon a time, when such letters were new, they might have fooled a few credulous souls. To-day they have no place in the category of any central station's advertising. Instead of insulting the intelligence of people by mailing out letters which plainly bear the earmarks of the spurious and which disgust folks with their weak effort at imitation, and thus are next to worthless as advertising matter, the central station can now procure imitation typewritten letters of such quality that to all intents and purposes are exact facsimiles of the real thing—so much so, in fact, that when the printed letter is inserted in the typewriting machine, and the name and address is filled in at the top of the letter, not even an expert can detect any difference between the filled-in name and the body of the letter.

MR. DRYGOODSMAN,
City.

DEAR SIR:

The bulk of your trade comes from that great class of workers who are too busy, daytimes, to walk the streets and notice store signs.

They get down-town only in the evenings.

Your painted wooden store sign is shrouded in darkness then—it can't be seen.

It means nothing to anybody.

Not even to you.

If it were an Electric Sign it would flash out its bright message to everybody on the streets.

Nobody would have to hunt it up.

It would hunt folks up.

It would burn your name and location in people's memories.

It would give your store a distinct, noticeable and favorable individuality.

It would put your store on people's minds and tongues.

It would give it prominence.

It would stamp your street number on the public memory.

Besides, even in the daytime, it is a better sign than a painted sign.

May we send a man to talk it over?

Yours truly,
JOHN DOE LIGHT AND POWER CO.

SPECIMEN LETTER No. 2.

Letters, with the stamp of genuineness like these, embody a character of the "personal" and exert a "personal" influence on the recipient, thereby insuring a more certain and more careful and more earnest reading of the letter.

In preparing a series of follow-up letters the writer should fix in his mind the idea that while "brevity is the soul of wit" it also is a quality which adds attractiveness to a letter and makes the letter inviting to read. It also goes far to hold the reader's interest and attention to the end.

The wisest plan in preparing such a series of follow-up letters is to devote each letter to a single feature, or two, of the proposition, and dwell on, and hammer, and pound, and drive these few features into the reader's mind impressively, deeply and past all forgetting—if you can.

Don't get the mistaken idea into your head that if your list numbers 5,000 names that you are writing your letter to 5,000 people all in one big bunch. It isn't so. You are talking, in your letter, to 5,000 single, separate individuals, one at a time. You are doing that just as much as if you had each one of these individuals alone on a desert island and were pouring out your fervid soul into his individual ear.

MR. DRYGOODSMAN,
City.

DEAR SIR:

The ordinary painted store sign is a joke.

And it's generally on the proprietor.

Nailed up flat against your store front, it is out of the way, hidden, as it were, from mortal eyes.

People on the same side of the street can't see it, and they haven't any uncontrollable hankering to walk out to the outer edge of the sidewalk and twist their necks at an uncomfortable angle to see it.

As a consequence your painted sign is a silent piece of uselessness.

Electric Signs are the signs that talk.

In the daytime they are as good as any sign, and at night they are better.

An Electric Sign compels attention.

It fills the horizon.

It reaches out its flashing arms to folks.

It reminds them of your store, your name, your location.

Its memory lingers with them.

It attracts them the first time they see it, and every time they see it afterward, and recalls your store to their minds.

If you will listen to our man we will send him to see you.

Yours truly,
JOHN DOE LIGHT AND POWER CO.

SPECIMEN LETTER No. 3.

After you have sent your man letter No. 1, and have given him something to think about, in a short while along comes your letter No. 2, giving him further hard facts and arguments to refresh and exercise his mind. Then, before he has had time to dismiss the subject from his

mind, along comes your letter No. 3, which begins where letter No. 2 left off, and furnishes him with additional proof

MR. DRYGOODSMAN,
City.

DEAR SIR:

Naturally you would like to make the name of your store a household word in town.

Possibly your newspaper advertising is a help to that end.

Probably your store sign is not.

Trouble is, nobody sees it. Daytimes it's a dead, flat, unnoticeable thing fastened to your store front.

Night-times the sable goddess wraps her black mantle about it, and it is obliterated from all eyes.

That's too bad.

The very folks you're after are the folks who work daytimes and can be on the streets evenings only.

Evening is the time to appeal to them, to attract their attention by an Electric Sign, to signal them along the street, to make them think of you.

It would arouse comment, it would give you "personal advertising," it would acquaint everybody in town with your store and its precise location.

Is an Electric Sign worth while?

We're ready to come and tell you.

Yours truly,
JOHN DOE LIGHT AND POWER CO.

SPECIMEN LETTER No. 4.

of your proposition. By this time he begins to think real things and wonder and wonder if you aren't just about right in what you claim, after all. Gradually, by

MR. DRYGOODSMAN,
City.

DEAR SIR:

This is the fifth letter we have written you about an Electric Sign for your store front.

But you have ignored us.

Are you made of adamant?

Are you steeled against all proof and truth?

We have laid before you some pretty poignant, potent reasons why you should have an Electric Sign.

If we have told the truth you can not afford to turn a deaf ear to us.

If you imagine we have lied to you we want you to write us, or invite us to call, so we can lay the downright, irresistible proof before your consideration.

If we fail we won't ask, nor expect, you to take any stock in our proposition.

If we prove our claims, the decision, then, lies wholly with yourself.

We simply ask a chance to show you—not urge you.

If we can convince you that an Electric Sign, instead of being a luxury, is a real store necessity, the choice will lie with you.

That's fair enough, it would seem.

Say the day, please.

Yours truly,
JOHN DOE LIGHT AND POWER CO.

SPECIMEN LETTER No. 5.

your persistent regularity in sending him these letters, you break down the barrier of initial indifference and begin to make your man sit up and take notice.

These letters should be written in a sort of serial story style, *i. e.*, each succeeding letter should continue the thread of thought, or argument, exploited in the preceding letter. In other words, the entire series of letters should form a connected chain of strong, penetrating, plausible, logical, forcible arguments, with no lull in between to allow your man a chance to yawn or grow cold. The whole series, taken and read together, should tell a long, continued, interlocking story of electricity and its advantages. The letters should be mailed out frequently enough so that the connection will not be broken. And each piece should be complete in itself, in case something should happen to cut off the balance of the series.

Such a series of letters, to exert its fullest potency, must be mailed out with almost clock-like regularity. Sent out, one piece every two weeks, you are practically sure of hitting your man within, at least, one week of the time when he happens to be in the mood to consider electricity. You can't expect to strike him at just the opportune moment with each piece you send him, but if you keep it up regularly and long enough you will come before him some bright morning at the exact crucial moment, and win him over.

Spasmodic advertising, or advertising sent out whenever you happen to feel like it, or whenever you happen to have a bit of superfluous time festering on your hands, isn't apt to reach your man at this "crucial moment"; in truth, it is more apt to "strike fire" and miss the mark altogether.

No mortal, thinking man, who considers his own interests, can forever hold out stubbornly against such a reasonable, earnest, hard-sense, regular and persistent series of "direct" personal advertising as this. It is bound, sooner or later, to insinuate its logical keenness into his discernment and cause him to think, then reason, then investigate, then act. And each of your succeeding letters, coming to him at regular intervals, gives him a fresh bump along the right way, and gradually, but finally, shoves him over the line of hesitating cogitation into the goal of action.

Such is the work of imitation typewritten letters.

Partly because they have the appearance of genuine "personal" missives.

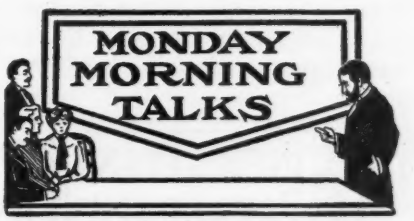
Partly because they are attractive, interesting, incisive, vigorous, logical, argumentative, truthful and convincing.

Partly because they reach the recipient regularly, every so often.

Partly because they are kept up long enough and persistently enough to wear down prejudice and win confidence.

It's the old simile, "Water falling day by day will wear the hardest rock away," all over again.

Let us apply it where it will exert its greatest usefulness.



Under this general heading we shall present to our readers a series of bright, stimulating talks to solicitors, which, we believe, will prove valuable to managers of new-business departments in suggesting points which they can profitably bring out in their occasional meetings with the company's representatives.

We shall gratefully accept contributions and suggestions from any of our readers.

Well, well, boys, I'm surprised!

To think that I should have to tell a bright, hustling lot of chaps like you to keep your eyes open more.

Think of it! Missing three good chances last week to annex a goodly supply of new current to the company's business because you were not wide awake.

But that's just what you missed.

I was surprised, on looking over last week's business Saturday night, to find that not one of you had approached the three new concerns that located here a week ago to-day.

What's your excuse?

Didn't know they were here, eh?

That's it exactly.

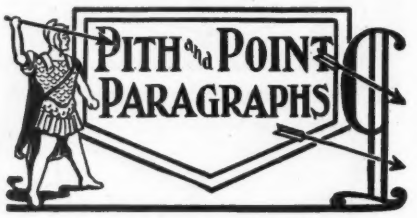
But isn't it a part of your business to know these things? If you'd only known about it you'd been after them hot foot and probably landed at least one of the three—maybe two—and who knows but all three? As it is, our competitors now have a good week's start on you, with good chances of winning these three accounts away from us.

And why? Simply because you didn't keep posted. Simply because you didn't read the daily papers fully. Simply because you didn't keep your eyes open more. Remember the wideawake salesman will find ways of creating business. He'll keep tab on business reports. He'll read the daily papers and the company's literature. He'll see where So-and-So has installed new machinery. He'll see where new buildings and residences go up. And lots of other things that can use current.

Now, don't construe this into a lecture, boys. It isn't—it's simply the facts. And facts are hard things to down. Don't for-

get you're here to get the business. For on your hustle and ability depends whether the ghost walks regularly for you each month. So don't let anything like this get away from you again. Keep your eyes open—wide open. And your ears, too. Wisdom, after all, is nothing more than the knowledge of our own and others' mistakes. Let this put you wise.

Well, now, to work, and let's see if we can't rustle up a nice bunch of new business the coming week.



Under this heading we shall, from week to week, present to our readers a little series of inspirational aphorisms (original, aboriginal and selected), which will, we believe, prove stimulating and suggestive to those who are interested directly or indirectly in the sale of central station current.

The solicitor who hopes to leave his "footprints on the sands of time" must have the sand to begin with.

Even an ass will not fall twice in the same quicksand.

Some of us occasionally ring the bell all right, but seldom hit the target at which we aim.

Bulldozing occupies the same relation to business that bull fighting does to farming.

A central station solicitor is in that field of endeavor which undertakes to supply the materials to humanity that a modern life demands.

The signed contract is the supreme court of the manager's opinion.

More contracts are lost by lack of courage and push than are ever realized by poor solicitation—and that's putting it pretty high.

Drive steadily.

Don't use all of your horse-power at once.

When your name is up you may lie abed till noon.

Where the busy bee solicitors are, there is business.

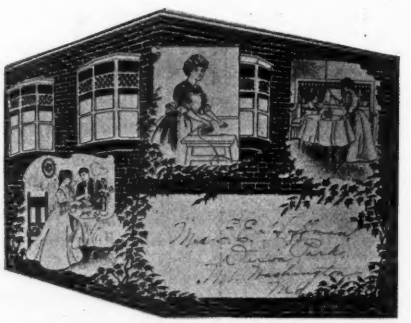
You may as much miss the mark by aiming too high as too low.

It will be our endeavor, from week to week, to present in this department brief notices of activities among the central stations, as gathered from men who are in the field and, consequently, in close touch with the progress of the new-business idea and its acceptance by central station managers. Contributions to this department are solicited, and will be received with much appreciation by the editor.

If you are doing something a little better than or different from the other fellows, and think it would make interesting reading to ELECTRICAL REVIEW readers, send in your schemes and plans. They will be gladly received.

Address all communications to Charles A. Parker, care of the ELECTRICAL REVIEW.

Mt. Washington, Md., a borough of Baltimore, is fortunate in having so up-to-date a central station as the Mt. Washington Electric Light and Power Company, which lights the boroughs of Towson, Govanstown, Ruxton, Melvale, Lutherville, Pikesville, Arlington and Mt. Washington.



A BUSINESS-GETTING MAILING CARD SENT OUT BY THE MOUNT WASHINGTON ELECTRIC LIGHT AND POWER COMPANY.

During the past few months an effective campaign of advertising through the mails has been centered upon the residence districts to a partial list of prospects. This campaign of advertising consisted of elaborately designed, well-written and printed booklets, folders, mailing cards and letters.

This company has recently made arrangements to issue a monthly bulletin about 3¼ by 6¼ inches in size to mail out to all of their present customers with monthly bills. This bulletin is intended to increase the sale of current of their present customers, as well as being along educational lines, so that present customers will be kept posted thoroughly on everything electrical.

During the coming year the company expects to make an exceptionally good showing over the past fine results, and in addition to their appropriation for direct-by-mail and newspaper advertising they have placed solicitors in the field to reenforce the advertising and "gather in the sheaves."

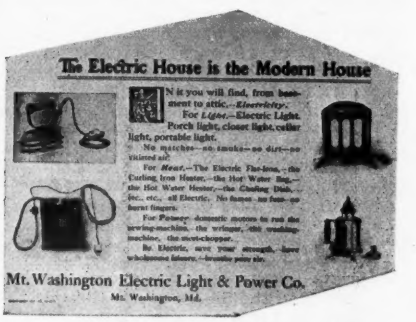
This company sells flat-irons, motors, appliances, etc., at cost, and also furnishes free lamp renewals.

Cordial relations with contractors who do the wiring is another strong feature which this company firmly believes in and has adopted very successfully.

As the company's territory is situated only in suburban residence districts, there naturally is not much chance for store lighting, but out of some eighty stores in the territory there are not any that amount to much that are not using this company's light.

The management of the company is especially watchful to take advantage of local conditions, as was illustrated lately when an epidemic of house-breaking occurred.

The company took advantage of this ill wind and by advertising to the public the electric porch light and its well-known virtues as a protection against evil doers, also emphasizing the advantages of having an electrically wired home, which could be instantly lighted from cellar to garret by the mere turn of the switch.



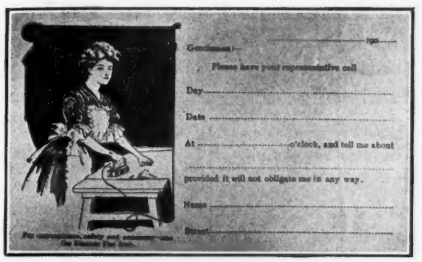
THE OTHER SIDE OF THE MOUNT WASHINGTON COMPANY'S CARD.

Taking everything into consideration, the management of the company is to be congratulated upon the progressive and up-to-date methods it is using to make known widely the different uses of electricity. Results are what count, and this company has certainly gotten the results in the past, and at a later date there will undoubtedly be some exceedingly interesting results to chronicle brought about by energy and progressiveness.

South Bend Electric Company, South Bend, Ind.—The surest evidence of satisfaction with the results of a line of action or a policy is the continuance and increased use of such methods and the in-

crease of the financial investment for such purposes.

So when it is stated that the South Bend Electric Company, of South Bend, Ind., has recently renewed for a second year their contract for advertising service with a well-known advertising company



ONE OF THE RETURN POSTAL CARDS ENCLOSED IN ALL BULLETINS SENT OUT BY THE SOUTH BEND ELECTRIC COMPANY.

and has decided to spend considerably more money for this purpose during the coming twelve months, it will be readily recognized that the campaign of the past year in direct-by-mail advertising has been eminently resultful and satisfactory.

One of the means used in this campaign to acquaint the people of South Bend with the merits of electricity is an attractive and convincing monthly bulletin which is

Which
Store?
Which store do you think would get the most trade—the light one or the dark one?
The people on the streets at night are influenced by electric light.
Many a sale is made or commenced after your store is closed, if you have electric light working overtime for you.
In your show windows, Electricity floods your entire store front with such alluring brilliancy that it beckons folks on the street; they cannot ignore it; they are naturally drawn to it.
It enhances the beauty of your display; it lends to your display an inviting appearance; it persuades folks.
It persuades them at the very time they are most open to impression—evenings.
The people who work daytimes form the great bulk of your trade.
What other time, pray, do your windows get a chance to talk to these people, but in the evening?
Does this sink in?
We're just waiting for a word from you to send our representative. When may he call?
South Bend Electric Co.
South Bend, Indiana

ONE OF THE SOUTH BEND ELECTRIC COMPANY'S MAILING CARDS.

mailed on the 5th of each month to a list of good prospects and customers.

This bulletin (six by nine inches in size, printed in several colors on heavy enamel stock) is well written and illustrated, and each month covers the entire field of electricity, telling of the healthfulness and convenience of electric light in the home, office, store and workshop; enlarging on the virtues of the electric motor as a means of propelling the sewing machine, wringer, meat chopper, etc., etc.; setting forth electricity's usefulness as an agent for cooking purposes and in a hundred different ways driving home the point that electricity is the thing for every purpose for which it is advocated in the bulletin.

The South Bend Electric Company's bulletin is sent out each month in attractive envelopes, printed in two colors, and always contains a return postal card, which makes it very easy for any interested person to communicate with the company by simply filling out a convenient appointment hour and his or her signature to the request for one of the company's representatives to call, affixing a one-cent stamp and mailing the card.

Whenever such a card is received at the company's office a solicitor is sent down at the appointed time to see the prospect, and must, of course, profit by the fact that it is at the prospect's own bidding that he is there.

The monthly bulletin is reenforced by other special advertising which is sent out to carefully compiled lists of customers and prospects.

One such service is used to tell of the special and peculiar merits of the electric sign in attracting custom and in stamping a merchant as successful and up to date.

Another service is used as a means of interesting the merchants and business men in window lighting, electric fans, showcase lighting and interior lighting.

Still a third service goes to power prospects and sets forth in no uncertain language the superiority of the South Bend Electric Company's sure and economical current as a means of power drive over the uncertain gas or gasolene engine and the wasteful and space-taking steam plant.

Special campaigns along similar lines are also sent to lists of residences, and serve to further emphasize the advantages of such devices as the electric flat-iron, sewing-machine motor, heating pad, chafing dish, broiler, hot water heater, etc.

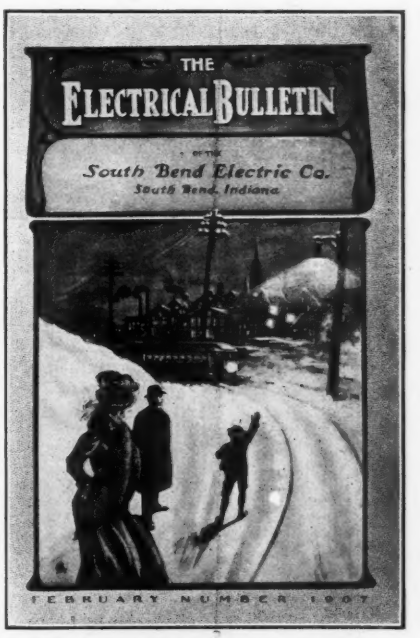
These special campaigns consist of attractive ads. in the way of booklets, folders, mailing cards, novelties and, last, but not least, excellent facsimile typewritten letters.

These letters are well gotten up and are especially effective, because the name of the customer or prospect is carefully struck in exactly the same kind of typewriter type as that with which the body of the letter is written, making it appear to the recipient exactly as though the whole letter had been specially written on the machine.

Such up-to-date methods of advertising as this company is using can not, it seems to us, fail to produce the right kind of impression and the results, as before noted, prove the efficacy of the use of first-class, high-grade advertising as a means to selling of more current to more people for more purposes, in fact, "all together, all the time, for everything electrical."

It is realized, however, that advertising needs forceful and aggressive solicitors behind it in order to be one hundred per cent effective, and here again the company's wisdom is shown by the fact that a most efficient staff of courteous and aggressive solicitors is maintained, whose energies are concentrated entirely on getting new business.

This company believes that their display room and electric sign attracts the desired attention, and is one of the best investments that any central station can



THE SOUTH BEND ELECTRIC COMPANY'S BULLETIN.

make. F. A. Bryan is the popular and energetic manager, and he deserves great credit for the progress and up-to-dateness exhibited by his company. He is ably seconded by the contract agent, W. J. Hall, who is very well known as being one of the "livest" new business specialists in the country.

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

The Dayton Ceiling and Desk Fans.

The Dayton Fan and Motor Company, Dayton, Ohio, is placing a strong line of fans on the market for 1907. Fig. 1 shows the Dayton No. 12. This is furnished with two or four blades, as desired. The voltages are 110, 170, 220 and 250. There is one speed of 215 revolutions per minute. These fans are finished in nickel, polished brass and oxidized copper.

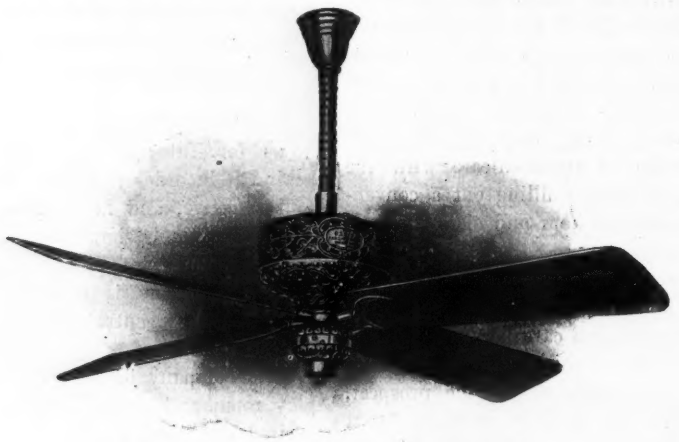


FIG. 1.—THE DAYTON NO. 12 CEILING FAN.

Fig. 2 shows the Dayton column fan No. 15. This fan is built for 110, 170, 220 or 250 volts. There is one speed of 215 revolutions per minute. The fan is finished in japan and nickel, japan and oxidized copper, or cream enamel and polished brass.

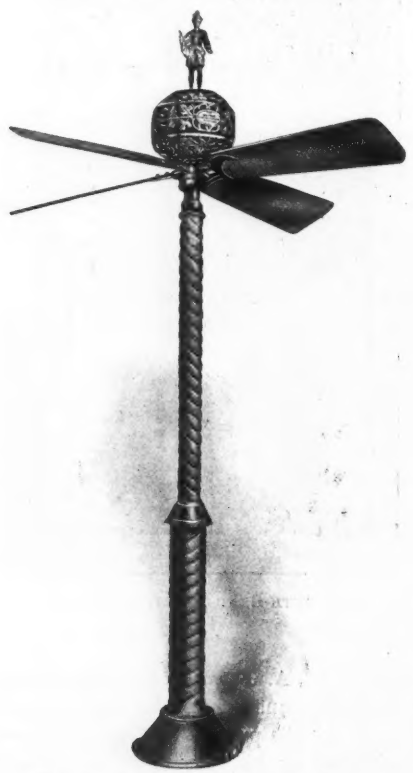


FIG. 2.—THE DAYTON COLUMN FAN.

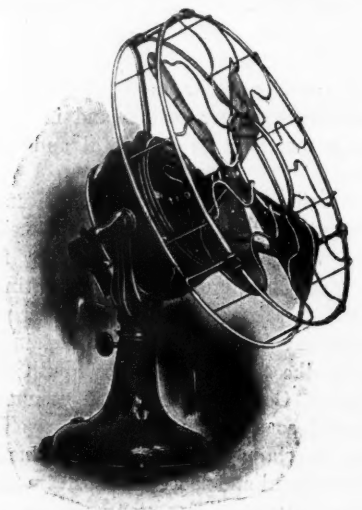


FIG. 3.—THE DAYTON SWIVEL TRUNNION FAN.

Fig. 3 shows the Dayton direct-current swivel trunnion fan, No. 18A. These fans are built for 110 and 220 volts direct-current. They have three speeds—1,800, 1,300 and 800 revolutions per minute. The finish is black enamel body with trimmings finished in polished brass, nickel or oxidized copper.

Emerson Fans for 1907.

The accompanying illustrations show several styles of Emerson and Trojan fans, made by the Emerson Electric Manufacturing Company, St. Louis, Mo., for the coming year. The Emerson and Trojan fans are marketed as entirely separate and distinct apparatus, each line embracing medium-speed desk fans in twelve and sixteen-inch sizes, slow-speed residence-type desk fans, and two and four-blade ceiling and column fans.

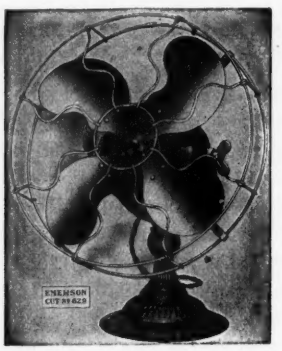


FIG. 1.—EMERSON SIXTY-CYCLE, MEDIUM-SPEED DESK FAN.

Fig. 1 shows the Emerson sixty-cycle, medium-speed desk fan made in the twelve and sixteen-inch sizes. These fans have Parker patented blades, half-inch hardened steel shafts and oil-tight bearings. Both Emerson and Trojan medium-speed, sixty-cycle desk fans have convertible bracket bases, permitting the desk fans to be changed into bracket fans without extra parts. Fig. 2 shows the desk fan converted into a bracket fan.

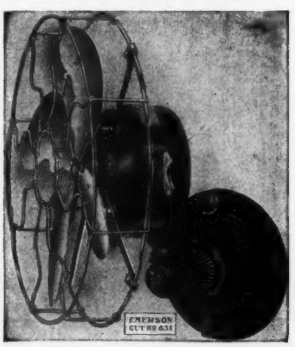


FIG. 2.—EMERSON BRACKET FAN.

Fig. 3 shows the form of winding adopted for the Emerson and Trojan me-

dium-speed, sixty-cycle desk fans. These fans are equipped with an automatic starting device, insuring prompt starting and a low current consumption.

Fig. 4 shows the Emerson residence-type fan. This fan is equipped with half-

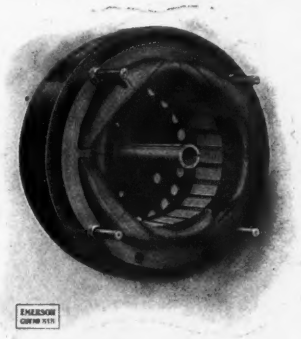


FIG. 3.—WINDING FOR EMERSON AND TROJAN MEDIUM-SPEED, SIXTY-CYCLE DESK FANS.

inch hardened steel shafts, Parker blades, convertible base and automatic starter. The fan, however, operates at a comparatively slow speed—approximately 1,100 revolutions per minute. It is a very quiet type of fan, but, as it has six blades, it throws a breeze which is entirely satisfactory for all purposes of home use.

Figs. 5 and 6 show, respectively, the Emerson and Trojan ceiling fans. The Emerson ceiling fan, both two and four-

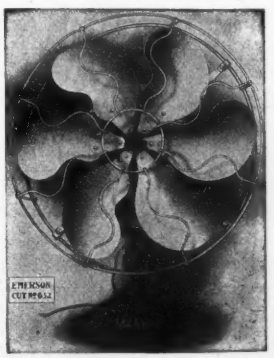


FIG. 4.—EMERSON RESIDENCE-TYPE FAN.

blade, are equipped with adjustable hangers, the hangers, trimmings and motor body all being finished in highly decorated oxidized copper. Both two and four-blade Emerson ceiling fans have speed coils giving three distinct running speeds, controlled by an indicating switch at the bottom of the motor.

The Trojan ceiling fans are regularly furnished with hanger hook, canopy and insulated hanger eye, but without hanger rods. These fans have the trimmings finished in oxidized copper, but the motor body is regularly finished in black japan. The Trojan ceiling fans have two speeds.

For high-frequency current the Emerson line includes medium-speed desk fans in twelve and fifteen-inch sizes, equipped with convertible base and automatic starting device. The Trojan line includes twelve and sixteen-inch, convertible-base, medium-speed desk fans for high-frequency; but while these fans are self-

FIG. 5.—EMERSON CEILING FAN.

starting, they do not have the automatic starting device. Both the Emerson and Trojan lines include two-blade ceiling fans. This style is not designed to throw the strongest possible breeze, but is intended for those installations where a moderate air current is preferred and a maximum speed regulation is desired.

The column fans in both Emerson and Trojan lines have but one speed, being

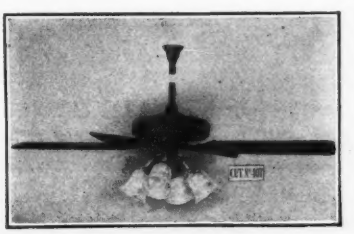


FIG. 6.—TROJAN CEILING FAN.

designed for use with ordinary type wall switches.

Emerson and Trojan ceiling and column fans are all direct-current motors of the pure induction type. The bearings consist of hardened steel balls operating between hardened steel raceways.

The Wagner Portable Combination Volt-Wattmeter.

The accompanying illustrations show a new portable volt-wattmeter placed on the market by the Wagner Electric Manufacturing Company, St. Louis, Mo. This instrument is being designed for the use of both central-station managers and manufacturers. The instrument carries a lamp socket embedded in the case, the socket extending about one-eighth of an inch outside the case. The lamp or attachment plug connected with the device under test is inserted in this socket. In the illustration (Fig. 1), at the right-hand side, may be noticed a hard-rubber switch which carries two pointers, one on each side. One of the pointers is marked 110 or 150 volts, as the case may be, and the other pointer is marked 220 or 300 volts, as the case may be. The instrument is designed for operation on both 150 and 300-volt circuits by throwing the switch

FIG. 1.—PORTABLE COMBINATION VOLT-WATTMETER.

to the proper voltage point. Each side of the switch travels over an arc which has three stopping points. The first reads "volts," the second "watts," and the third "off."

The instrument has a double scale, a voltage scale reading up to 150 volts and

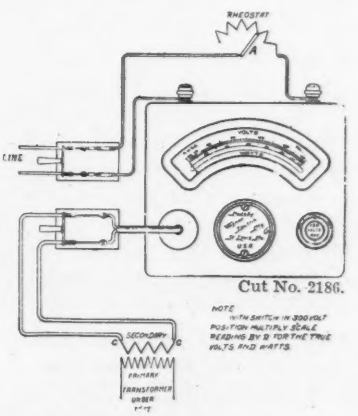


FIG. 2.—CONNECTIONS OF PORTABLE COMBINATION VOLT-WATTMETER.

a wattage scale reading up to 150 watts. One needle covers both scales.

The instrument as ordinarily furnished is put out in a neat hard-maple carrying case. If desired, the apparatus is fur-

nished with a leather carrying case with shoulder strap.

The illustration herewith (Fig. 2) shows the method of connecting the instrument and a transformer under test to the test circuit.

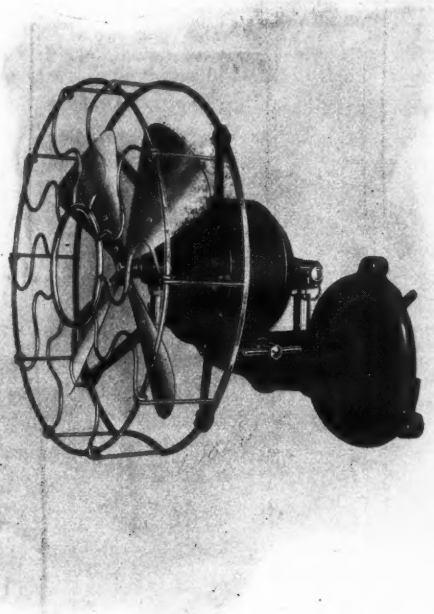


FIG. 1.—TYPE "GG" PEERLESS DIRECT-CURRENT BRACKET FAN.

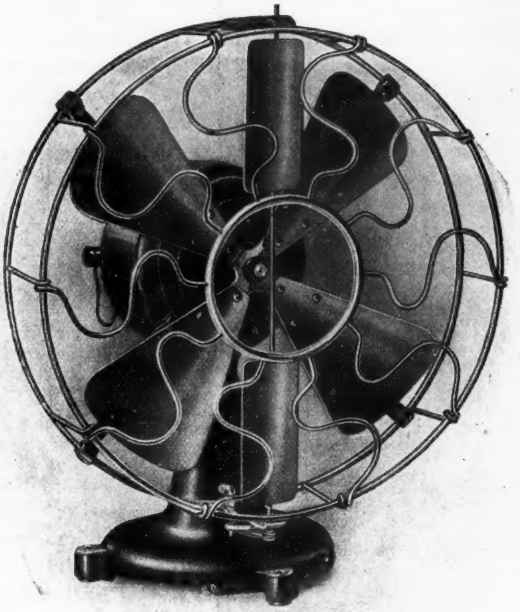


FIG. 2.—TYPE "ODD" PEERLESS OSCILLATING FAN.

Peerless Fan Motors for 1907.

The Peerless fan motors for 1907, manufactured by the Peerless Electric Company, Warren, Ohio, embody all the features that have made this line distinctive heretofore. A number of parts have been brought to a further degree of efficiency through changes in detail design. The Peerless swivel and trunnion desk fans of the 1907 model are instantly convertible into bracket fans by merely adjusting a single thumbscrew at the trunnion. A more positive device has been adopted for catching any oil that happens to escape from the bearings. Close attention is given to the finish, and the interior of the motors is also japanned, precluding rust and providing extra insulation.

The Peerless ceiling fans have been improved, an alteration in the switch at the top of the fan making it almost impossible for the lead wires to be broken off. The ceiling fans have also been redesigned for increased speed, to meet the demand in that direction.

Fig. 1 shows the type "GG" direct-current bracket fan. This is of the iron-clad style, having heavy bronze bearings, large oil cups and small cartridge brush-holders. The guard and blades are finished in lacquered brass.

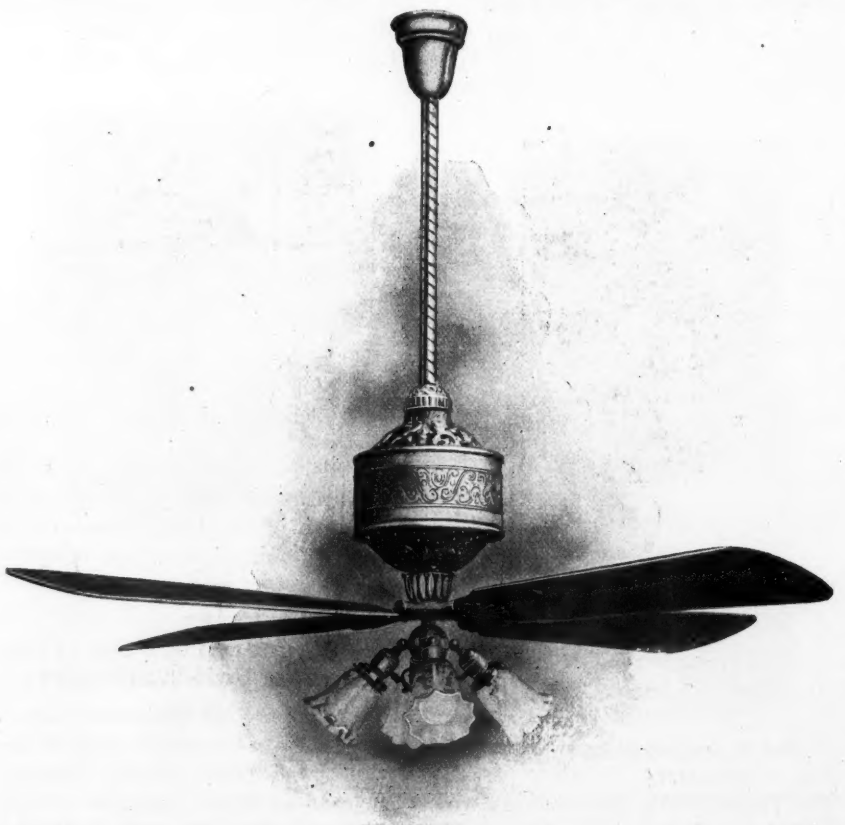


FIG. 3.—TYPE "HH" PEERLESS DIRECT-CURRENT CEILING FAN.

Fig. 2 shows the type "ODD" oscillating fan. The simple mechanism is actuated by a shifting vane located inside the guard. The reversals of oscillation are cushioned by the air from the blades, doing away with any jar and consequent racking of the moving parts. The fan

body rotates on a special ball bearing, the parts of which are made from high-grade steel carefully hardened and ground. The switch in the base of the fan affords two speeds. The brackets supporting the actuating vane are rigidly fastened to the guard, and these brackets also carry the throwing lever. Current is transmitted from the main circuit through carbon brushes to collector rings mounted on the bearing shaft. By the use of collector rings there is no possibility of the lead wires wearing off in consequence of the oscillating movement. The switch, brush-holders and collector rings are entirely contained within the base of the fan.

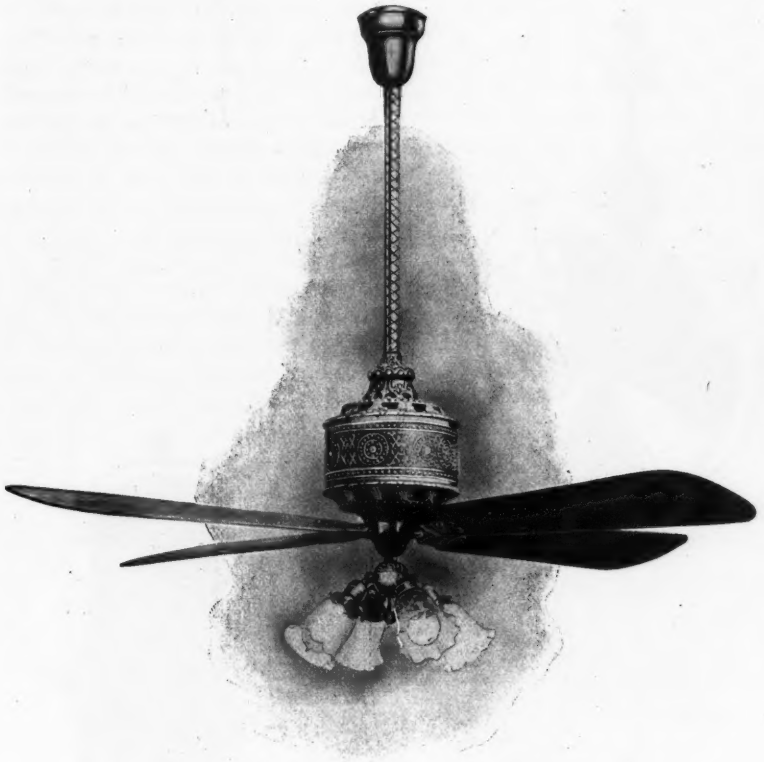


FIG. 1.—TYPE "RR"-2 COLONIAL DIRECT-CURRENT CEILING FAN.

Fig. 3 shows the type "HH" direct-current ceiling fan with four-light electrolier attachment.

Colonial Fans for 1907.

The Colonial Fan and Motor Company, Warren, Ohio, will make no material changes in its line of fans for 1907. As the result of some exhaustive tests, some minor changes have been made which improve the fans in many respects. The speed has been increased without increasing the current consumption. The desk fan oil cup is now made in one piece, making it easier to fill and adjust. The ceiling fan switch has been improved and is now so constructed as to protect the feed wires, obviating the possibility of their becoming loose or twisted off.

Fig. 1 shows the type "RR"-2 direct-current ceiling fan and electrolier. The standard length of fan from ceiling to lowest extremity is four and one-half feet. The 170, 250 and 500-volt fans have one speed only.

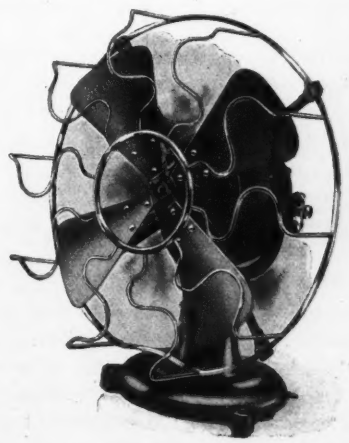


FIG. 2.—TYPE "TT" COLONIAL DESK FAN.

Fig. 2 shows the type "TT" desk fan. This fan has three speeds, is furnished with brass-finished guard and blades and equipped with swivel and trunnion movement.

Induction Motors in Havana, Cuba.

That manufacturing interests in Cuba have not been slow to realize the advantages of electricity for power purposes is indicated by the increasing exports of electrical apparatus to that country. This is especially true of induction motors, two recent applications of which in Havana—one from a viewpoint of economy alone, the other from consideration of novelty as well as economy—may prove of interest.

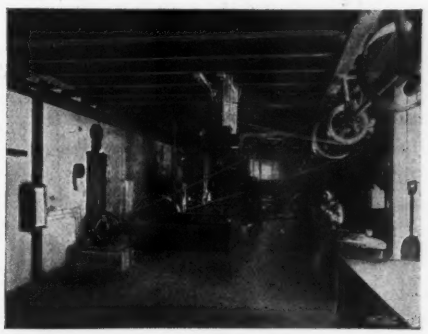


FIG. 1.—FIFTEEN-HORSE-POWER INDUCTION MOTOR INSTALLED IN CIGAR BOX MANUFACTORY.

Fig. 1 shows a fifteen-horse-power, 1,200-220-volt, form L, induction motor, installed in the cigar-box manufactory of Diaz & Vega. This motor operates, through a line shaft, a large number of small circular and jig saws on the first and second floors of this establishment. The interesting part of this installation consists in the fact that a steam engine and boiler costing to install some $3,500, when still new, were replaced by the motor above noted at a fraction of the cost of the steam plant.

FIG. 2.—RUBBING BED AND TILING MACHINE.

The new "Centro Dependiente" Club House now building on the Prado, Havana, will be, when finished, both the largest and most costly building on the island of Cuba. Large quantities of marble tiling are being used in the construction of the floors and staircases, for the rapid installation and finishing of which

the "rubbing bed and tiling machine" shown in Fig. 2 was devised. This machine is operated by a fifteen-horse-power induction motor. It is interesting to note that four men working at the electrically driven "rubbing bed" can accomplish in one day what formerly would have required a week with the same number of operators using older methods.

Both of the motors mentioned were sold through Messrs. Sussdorf, Zaldo & Co., agents for the General Electric Company in the island of Cuba.

Fort Wayne Fan Motors for 1907.

The "Wood" fan motors, made by the Fort Wayne Electric Works, Fort Wayne, Ind., are built in five types—desk, revolving, dragon bracket, universal bracket and telephone booth; and in two sizes—eight inches and ten inches, for direct current and alternating current, sixty, 125 and 140 cycles. The mechanical construction is different in the five types, but the electrical parts are the same. A spherical shell contains the moving and actuating parts of the motor, and in the desk type this shell is mounted on a pedestal with the fan shaft horizontal. In the revolving-type motors the shell is suspended from a ball bearing, about which it is free to turn, and the fan shaft is inclined at an angle of forty-five degrees.

In the dragon bracket type the shell is suspended from stationary springs, and the shaft has the same angle as in the revolving motor, but the shell is not free to revolve.

In the universal bracket type the shell is rigidly suspended from a circular goose-neck, which allows the shaft to be inclined at any angle desired. The field structure is mounted on one-half of the spherical shell enclosing the motor. The two halves are held together by four bolts, which also carry the fan guard.

FIG. 2.—"WOOD" SUSPENDED REVOLVING-TYPE FAN MOTOR.

The inductor-type armature is used on 140-cycle, alternating-current motors, and the commutator-type armature on sixty-cycle alternating and direct-current motors.

Fig. 1 shows the ten-inch stationary desk-type motor. This is built with an eight or ten-inch brass fan and guard. The standard finish is black body and pedestal. Fig. 2 shows the suspended revolving type of fan motor.

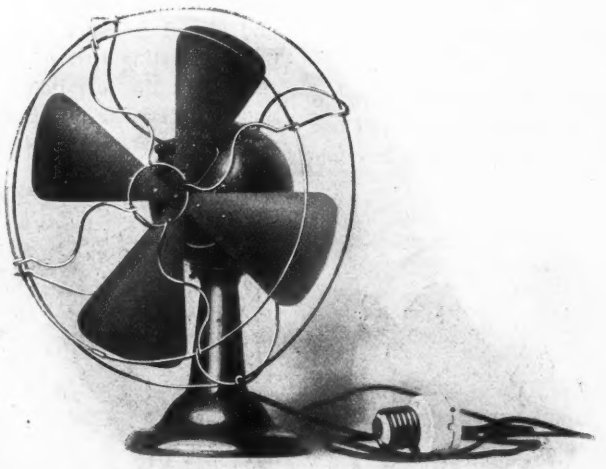
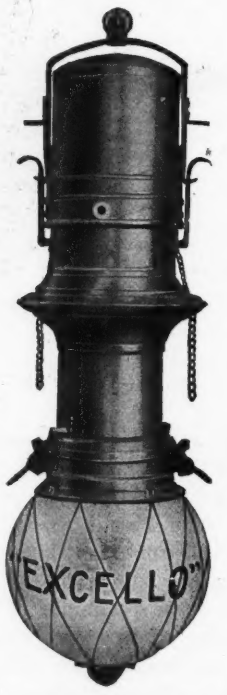


FIG. 1.—"WOOD" TEN-INCH STATIONARY DESK-TYPE FAN MOTOR.

A New Flaming Arc Lamp.

A new flaming arc lamp is being put upon the market by the Beck Flaming Lamp Company, 30 Greenwich avenue, New York city, which embodies a number of new features. The idea governing the new design has been to obtain a lamp as simple in mechanism and as little liable to interruption as possible. This result has been reached by doing away with a large part of the mechanism usually thought essential for such lamps, and placing in it only that which is absolutely necessary. This feature, together with a construction of the frame which excludes from the inner parts of the lamp all smoke liberated during operation, has accomplished the end sought.

The mechanisms of the lamp consist simply of a striking magnet, which is connected in series with the arc and operates only to start the lamp, the carbon-holders, which are simple weighted spring clips sliding on inclined rods, and the guides through which the carbons pass, and by means of which they are separated by the striking magnet. There is in addition a small resistance for steadying the lamp.



THE BECK FLAMING ARC LAMP.

The regulation of the arc is effected in the usual way by a rib on the carbon rod, which rests upon a copper support and is burned away as the arc lengthens. The regulation is thus entirely automatic, calling for no moving mechanism nor gears and clutches; and the support for the

carbon is not heated sufficiently to be injured.

Current is fed to the arc, not through the carbon holder, but by means of the guide and support. In this way it does not pass through a carbon path of varying length, and hence of changing resistance, so that the voltage at the arc is not affected by this.

The arc itself is surrounded by an economizer of cast-iron, upon which all solid oxides formed during combustion are deposited. Within this economizer is fitted an Alberene stone disc, which prevents the passage upward of any vapors; and it also, through a downward movement imparted by the starting magnet, effects the separation of the carbons and strikes the arc. Lamps of this type which have been in operation for some time and brought back to the factory, upon being taken apart, show that the inner part of the casing and the lamp mechanism are clean and are not coated in the usual way by a heavy deposit of oxides; in fact, the parts retain their original polish.

The insulation of the lamp is of porcelain, Alberene stone and micanite, and is thus fireproof—a very necessary feature for lamps of this type, since the temperature attained within them is high.

The lamps are made for both alternating and direct currents. In the former case a small autocoil reduces the voltage to that required. In this lamp there is no deflecting magnet, the effect of the current itself being sufficient to deflect the arc. The direct-current lamp requires two small coils in order to produce the desired fanning-out of the arc.

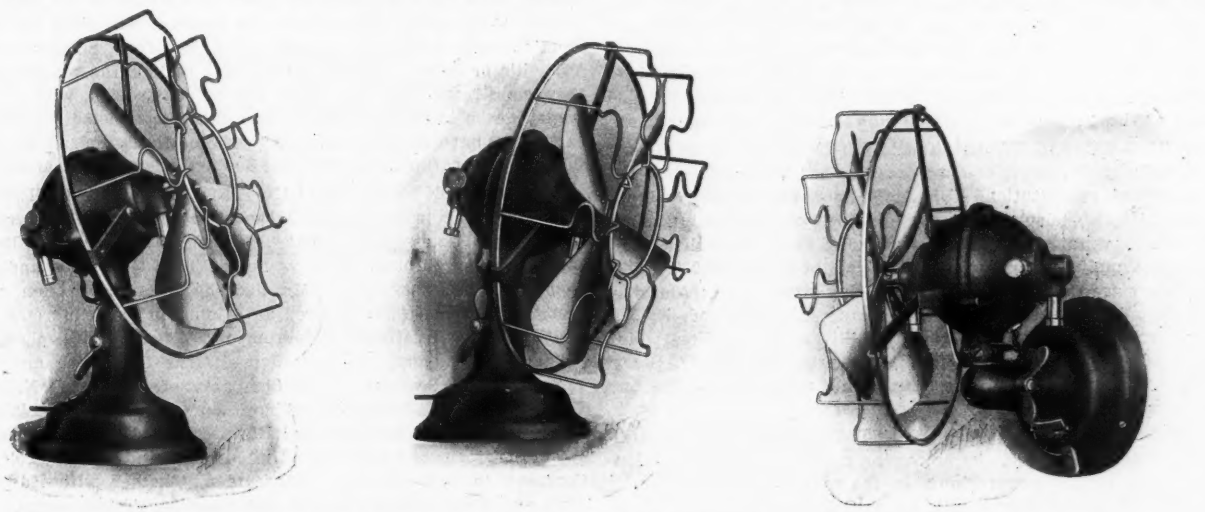
The lamp is a straight series lamp, and may be run in series on 100 to 120 volts. The alternating arc lamp, it is said, may be run on any frequency from twenty-five to 133 cycles per second. When run on low frequency the variation in the arc is said to be much less noticeable than that of the open or enclosed arc lamps of the ordinary type.

The appearance of the lamp is shown in the accompanying illustration. The case is simple and neat and provides excellent ventilation. The lamp complete weighs only twenty pounds, is thirty-two inches long and has a nominal rating of 3,000 candles. The color is either golden-yellow or brilliant white, as desired.

Lundell Direct-Current Fan Motors for 1907.

The Lundell direct-current fan motors, manufactured by the Sprague Electric Company, New York city, have been greatly improved for the season of 1907, with a view of embodying in one fan all the features of the solid base desk, the swivel and trunnion desk, and the swivel and trunnion bracket types. This has been accomplished by dispensing with the usual swivel and trunnion arrangement and substituting therefor a universal joint as a connection between motor and base, which enables the fan to be used interchangeably as desk or bracket type. This construction presents obvious advantages to both dealer and user. For the dealer it greatly simplifies the problem of stock, as he will need to carry only one type instead of three. To the user it offers a fan which may be placed with equal facility upon wall or desk, and can be readily adjusted to move the air in any direction desired.

In addition to the new universal joint many other improvements are incorporated in this season's fan motor. The guard has been greatly strengthened by more rigid bracing and by the adoption of heavy rectangular wire for the guard ring. Broad improvements have been made in such details of construction as bearings, arrangement of switch and switch handle, etc., all of which will make this fan even more reliable than previous Sprague models.



THREE VIEWS ILLUSTRATING THE ADAPTABILITY OF THE LUNDELL DIRECT-CURRENT ADJUSTABLE-TYPE FAN MOTORS.

Remote-Control Switches.

The development of a reliable remote control, or automatic switch, that obviates the necessity of carrying heavy feed wires to the point from which it is desirable to control electric power is a matter of much interest to the architect and engineer in developing the electrical plans for mill, theatre, auditorium or residence wiring.

The type D-2 switch, manufactured by the Pettingell-Andrews Company, Boston, Mass., may be adapted to a great variety of uses, as may be judged from the fact that they are being used for purposes as widely separated as the entire control of lights in large auditoriums to use in connection with automatic fire alarm systems to cut out electrical service in time of an emergency.

They are usually installed to control lights or power at points that take advantage of the natural centres of distribution of the building, the operation of the automatic switches being controlled by push buttons so as to permit of all the lights, etc., of the building being controlled from one or more central points, vastly increasing the flexibility of the system, at the same time increasing its safety, convenience of operation and economy of installation.

A great many of these switches have been installed to control small alternating motors that may be thrown directly across the line, in one recent installation the motor being controlled from sixteen different points in connection with a vacuum cleaner system.

Current Electrical News

DOMESTIC AND EXPORT.

MILWAUKEE ELECTRIC RAILWAY AND LIGHT COMPANY—The Milwaukee (Wis.) Electric Railway and Light Company stockholders have authorized an issue of $20,000,000 and of this amount $4,000,000 are now outstanding. Of this unissued $16,000,000 of these bonds, $8,000,000 are reserved to be retired at maturity, underlying liens, and $8,000,000 are held in escrow, to be issued after January 1, 1908, to an amount not exceeding $1,000,000 a year, the proceeds to be used for extensions, improvements and acquisitions. Refunding and extension mortgage four and one-half per cent bonds to the amount of $1,000,000 are now being offered at 95¾ and interest.

CHICAGO & MILWAUKEE ELECTRIC SHORT TERM NOTES—The Western Trust and Savings Bank, of Chicago, has arranged with the Chicago & Milwaukee Electric Railroad Company to place an issue of $2,000,000 two-year six per cent collateral and convertible gold notes dated March 1, 1907, due March 1, 1909. The notes are secured by deposit with the Western Trust and Savings Bank, Chicago, trustee, of $2,500,000 Chicago & Milwaukee Electric Railroad Company, Wisconsin division, first mortgage five per cent guaranteed gold bonds of 1925. The proceeds of the $2,000,000 note issue are to be used for the completion of the road into Milwaukee, for the payment of the Milwaukee terminals and for additional equipment.

LARGE NEW ELECTRIC COMPANY INCORPORATED—The Bolivia Railway Company, of Hartford, Ct., has filed articles of incorporation and organization. It has broad powers, including operating railroad lines, telephones, telegraph lines, vessels, maintaining water powers, running gas or electric plants, and many others, but these do not apply in Connecticut. The capital is $10,000,000. The incorporators are Edward W. Burdick, of Englewood, N. J.; Aloysius C. Gahan, of New York; Jacob G. Metcalfe, of Lakewood, N. J.; Arthur Starke, of New York; Frank L. Sullivan, of New York. Mr. Metcalfe is president, Mr. Burdick is vice-president and H. Starr Giddings, of New York, is secretary and treasurer. The incorporators are the directors.

LARGE POWER PLANT TO BE ESTABLISHED—The General Electric Company is said to be promoting a scheme for the erection of one of the largest power plants in the country at Buck's Neck, in the Hoosick river, about a mile below Schaghticoke, N. Y. It is proposed to put a dam across the Hoosick river at the village of Schaghticoke; to convey the water through a tunnel or canal to the power station; to convert into a large lake part of the lowlands of the village of Schaghticoke; to submerge a portion of the tracks of the Boston & Maine Railroad; to build a reservoir which will be one of the largest in the world near Johnsonville; to flood the country back of it, obliterating a portion of the village of Buskirk, and to furnish electric light and power to all eastern and a large portion of southern New York. The consents and water rights required for this big undertaking have, it is said, been almost all obtained. The engineering operations are being conducted by the firm of Viele, Cooper & Blackwell, of New York.

FIVE MILLION DOLLARS FOR NEW CAR LINES—To carry out its plans of new construction work the Oakland (Cal.) Traction Company has increased its bonded indebtedness by $5,000,000. Of this $2,500,000 has been set aside for immediate expenditure in heavy construction work, extensions and improvements, affecting virtually the entire system. Another $2,500,000 will be utilized in the near future in developing important projects, plans for which are maturing. These plans cover a comprehensive extension of street railway service in many sections of the cities now tapped by the lines. Disclosures concerning the company's projects have been made public by the filing of a deed of trust from the Oakland Traction Company to the Union Trust Company, of San Francisco, covering the properties of the company and securing an issue of $12,000,000 in bonds. The bonds are to run twenty years and to bear five per cent interest. Of the issue $7,000,000 will be used to retire an equal amount of bonds of the Oakland Traction Consolidated, which has been merged into the Oakland Traction Company.

PLANS COMPLETED FOR ST. LOUIS-CHICAGO ELECTRIC LINE—William McKinley, head of the Illinois Traction System, announces the closing of arrangements for the construction at once of an air electric road between St. Louis and Chicago. Of this distance the 130 miles from St. Louis north to Lincoln, the county seat of Logan county, is already in full operation, running limited cars and sleepers. From Lincoln this summer the company will build north to Mackinaw, in Tazewell county, and from Bloomington to Peoria. From Mackinaw the line will be pushed northeast through Washington and Eureka, in Woodford county, then to Minonk on the Illinois Central in Woodford county, thence north to Streator, thence on to Ottawa, thence directly east to Seneca and from Seneca either to Yorkville or Joliet. At Yorkville it will connect with the Aurora, Elgin & Chicago. At Joliet it will connect with the Chicago-Joliet line. In addition to the road from Lincoln to Mackinaw this summer the company will build the stretch from Streator to Ottawa, sixteen miles, and from Seneca to either Yorkville or Joliet. During the summer of 1908 the remaining gap between Streator and Mackinaw will be constructed, with a cut-off from Eureka to Peoria. By the time this is completed the company expects to have its new bridge across the Mississippi, at St. Louis, finished, and cars running into the business district of that city.

INJUNCTION SECURED IN TELEPHONE MERGER—New York State Attorney-General Jackson has delayed the merger of the United States Independent Telephone Company with Bell interests, acting through the New Jersey Title Guarantee and Trust Company, of Jersey City. Mr. Jackson began an action in the name of the people and secured an injunction from Supreme Court Justice Fitts at Albany, enjoining the American Telephone and Telegraph Company, the New Jersey Title Guarantee and Trust Company, the Security Trust Company, of Rochester, N. Y., or George Eastman, Hiram W. Sibley, James S. Watson, Walter B. Duffy, Thomas W. Finucane and Edward Bausch from turning over any of the stocks or bonds of the United States Independent Telephone Company to Bell interests Those men, together with Edward J. Hall and Frederick P. Fish, of the American Telephone and Telegraph Company; Albert O. Fenn, of the Alliance Bank, Rochester, and Joseph W. Taylor were cited to appear at Albany March 7 and produce all documents relating to the proposed transfer of control of the United States Independent Telephone Company to the American Telephone and Telegraph Company. The Security Trust Company has been securing seventy-six per cent of the $13,500,000 of outstanding bonds of the United States Independent Company and sixty-seven per cent of the stock on an offer of $350 for a bond that sold on the market about a year ago for $820, and $5 for stock shares that sold for $55, and had the desired amount of bonds when the injunction was served. Holders of about $2,000,000 more can not now turn in. The United States Independent Telephone Company recently absorbed the New York Independent Telephone Company, a $50,000,000 corporation.

DATES AHEAD.

Railway Signal Association. Chicago, Ill., March 18.

Underwriters' National Electric Association. Annual meeting Electrical Committee, New York city, March 27-28.

Ohio Independent Telephone Association. Annual convention, Columbus, Ohio, March 28.

West Virginia Independent Telephone Association. Wheeling, W. Va., April.

Iowa Electrical Association and Iowa Street and Interurban Railway Association. Clinton, Iowa, April 18, 19 and 20.

Southwestern Gas, Electric and Street Railway Association. San Antonio, Texas, April 18-21.

Jamestown Tercentennial Exposition. Norfolk, Va., April 26 to November 30.

Railway Telegraph Superintendents' Association. Annual meeting, Atlantic City, N. J., June 19-20.

PERSONAL MENTION.

MR. E. P. COLEMAN, who has been manager of the Consolidated Electric Light Company, of Montpelier, Vt., has been appointed superintendent of the Duluth Power Company, Duluth, Minn., which is completing an extensive electric system.

MR. J. WHITE SPRONG, of Albany, N. Y., purchasing agent for the Delaware & Hudson Company, has been appointed to a similar position with the United Traction and Hudson Valley companies, which are controlled by the former, the appointment to be effective at once. Mr. Sprong will have charge of purchasing all apparatus and supplies for the three railroads. Another appointment made by the Delaware & Hudson officials is that of Axel Eckstrom, the consulting electrical engineer of the company, to have charge of the mechanical and electrical work of the two trolley roads. Mr. Eckstrom, who was elected a director of the Hudson Valley company, at a recent meeting in Albany, will have the title of general electrical and mechanical superintendent of the traction department.

OBITUARY NOTE.

MR. EUGENE H. LEWIS, a prominent member of the legal department of the General Electric Company, died suddenly in New York city on March 1. Mr. Lewis was at one time attorney for the Schenectady (N. Y.) Railway Company, and was once closely associated with Samuel Insull and Thomas A. Edison. He married Amy Busby, the actress, and is survived by his widow and three children.

NEW INCORPORATIONS.

ALBANY, N. Y.—The Brooklyn Telegraph and Messenger Company, of Brooklyn. Capital stock increased from $100,000 to $200,000.

AUSTIN, TEX.—Western Light and Power Company, of Cisco, Eastland county. $50,000. Incorporators: W. E. Anderson, M. V. Mitchell, W. A. McSpadden.

JEFFERSON CITY, MO.—West Side Terminal Railway Company, of St. Louis. $1,000,000. Incorporators: Collins F. Newton, Ard D. Neff, William H. Miller and others.

GUTHRIE, OKLA.—Fargo-Harmon Telephone Company, of Fargo. $1,500. Incorporators: G. W. Bailey, W. R. Hill and C. A. Stromberg, of Fargo; C. E. Castiller, of Harmon.

GUTHRIE, OKLA.—Farmers' & Merchants' Telephone Company, of Mutual, $4,988. Incorporators: A. Huffman and Louis Morgan, of Mutual; G. C. Harper, of Moscow; Jacob Feathergill, of Persimmon.

NEW MANUFACTURING COMPANIES.

DETROIT, MICH.—The Clark Electrical Company, which will engage in a general electrical supply business, has filed articles of association. Its capital stock is $35,000, of which $30,000 is common stock and $5,000 preferred. The shares are held by William C. Clark, Delphos L. Berry, Joseph W. Martin and G. A. Clark.

ROCHESTER, N. Y.—The Police and Fire Alarm Telephone Company, of Rochester, has been incorporated with a capital of $500,000, to manufacture a telephone device designed for attachment to fire-alarm boxes, to be used by the police. The directors of the company are George F. Roth, Charles T. Chapin, James L. Hotchkiss, Merton E. Lewis and Clarance McKay.

OWENSBORO, KY.—Articles have been filed incorporating the Phillips Signal and Electric Company. Dr. C. C. Phillips, Frank Katterjohn, Richard Tennelly, W. Forster Hayes, J. Robert Tennelly and R. S. Hughes are the stockholders. Owensboro is to be the principal place of business. The capital stock is $50,000, divided into shares of $100 each. The indebtedness shall not exceed $10,000. The corporation is to commence at once and continue for twenty-five years. The purpose is to own, handle, manufacture and develop the signal devices for preventing accidents invented by Dr. C. C. Phillips, but especially the device known as the Phillips automatic signal and the Phillips trolley cutout.

ELECTRICAL SECURITIES.

Feverish and active speculation characterized last week's stock markets. The general tendency was downward, and despite a slight recovery from the lowest prices, the general average shows many net losses. It is assumed that the Harriman investigation has been the main speculative influence. The possibility exists, of course, that public confidence in the leading financiers and capitalists will be shaken, and, in consequence, the unsettling movement will continue, with still lower prices. It is quite possible that legal action will be taken to end the dual control of several of the most prominent industrial and railway corporations. Until this matter has been definitely settled it is likely that there will be but little resumption of public participation in stock market speculation.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MARCH 2.

New York:	*Closing.*
Allis-Chalmers common	13½
Allis-Chalmers preferred	34½
Brooklyn Rapid Transit	68¾
Consolidated Gas	136
General Electric	157
Interborough-Metropolitan common	30¼
Interborough-Metropolitan preferred	65½
Kings County Electric	140
Mackay Companies (Postal Telegraph and Cables) common	72¼
Mackay Companies (Postal Telegraph and Cables) preferred	69⅜
Manhattan Elevated	142
Metropolitan Street Railway	104
New York & New Jersey Telephone	113
Western Union	80½
Westinghouse Manufacturing Company	150

The directors of the New York & New Jersey Telephone Company, who were reelected at the annual meeting of stockholders, organized by the reelection of the present officers. With this exception only routine business was transacted.

The regular quarterly dividend of one and three-quarters per cent on the stock of the Metropolitan Street Railway Company, paid as rental by the New York City Railway Company, will be payable April 1. Books close March 20 and reopen April 2.

The stockholders of the Kings County Electric Light and Power Company, at their annual meeting, ratified the increase of the capital stock of the company from $5,000,000 to $10,000,000. The retiring directors were reelected.

Boston:	*Closing.*
American Telephone and Telegraph	125½
Edison Electric Illuminating	220
Massachusetts Electric	67
New England Telephone	120
Western Telephone and Telegraph preferred	77

Philadelphia:	*Closing.*
Electrical Company of America	10
Electric Storage Battery common	60
Electric Storage Battery preferred	60
Philadelphia Electric	8⅛
Philadelphia Rapid Transit	21
United Gas Improvement	92¼

The annual meeting of the stockholders of the Electric Storage Battery Company will be held March 20. Books closed February 27 and will reopen March 21.

Chicago:	*Closing.*
Chicago Telephone	117½
Chicago Edison Light	140
Metropolitan Elevated preferred	67¾
National Carbon common	81
National Carbon preferred	115¼
Union Traction common	—
Union Traction preferred	—

The average number of fares carried during February by the Metropolitan Elevated of Chicago was 154,443, an increase of 18,873.

The average number of passengers carried daily during February on the South Side Elevated was 96,098, an increase of 1,017 over the previous month. The regular quarterly dividend of one per cent on South Side Elevated is payable March 30.

ELECTRIC LIGHTING.

TEKAMAH, NEB.—An ordinance has been passed by the city council appropriating $10,000 for the installation of a municipal light plant.

MANCHESTER, N. Y.—The Manchester town board has granted a franchise to the Niagara, Lockport & Ontario Power Company, permitting it to cross the highways in the town of Manchester.

HERINGTON, KAN.—Final arrangements have been made by the city council of Herington for the transfer of the electric light as well as the water plant from private corporations to the municipality.

SOMERSET, PA.—The stockholders of the Somerset Electric Light, Heat and Power company have elected the following officers: Dr. J. M. Louther, president; Hon. A. W. Knepper, vice-president; J. M. Bricker, secretary, and Charles H. Fisher, treasurer.

ORD, NEB.—Articles of incorporation have been filed for the Ord Electric Light and Power Company, capitalized at $20,000, half paid up. The organizers are F. J. Bell, A. P. Jensen, C. E. Detweiler and Clarence Smith, all local men of recognized financial ability.

TORONTO, ONTARIO—The Toronto Electric Light Company is now receiving 2,500 horse-power and the Toronto Street Railway Company 4,000 electric horse-power from the Electrical Development Company, of Niagara Falls, over the transmission line of the Toronto & Niagara Power Company.

EATON, OHIO—At a meeting of the town council the Eaton Electric Light Company was granted a twenty-five-year franchise for the use of the streets and alleys. The conditions are that the present system is to be reconstructed, work to begin at once and to be completed by January 1, 1908.

ALBIA, IOWA—The property of the Albia Electric Light and Power Company has changed hands. The new proprietors are men who are known to be interested in the same company that controls the Oskaloosa light company as well as the interurban that is now being constructed to Buxton from that place.

CENTRAL CITY, COL.—The city council of Black Hawk has extended the franchise of the Gilpin County Light, Heat and Power Company for ten years. This is the company which was reported to have sold out to the Colorado Central Power Company for over $500,000, local stockholders denying the report.

ANNAPOLIS, MD.—At the annual meeting of the stockholders of the Annapolis Gas and Electric Light Company of Anne Arundel county, the following were elected directors for the ensuing year: W. H. Gorman, W. H. Bosley, J. S. Gittings, H. L. Pope, W. H. Bosley, Jr.; L. H. Rhen, G. D. Ridout, J. W. Randall, J. C. Bosley.

ELLSWORTH, ME.—The Bar Harbor & Union River Power Company has awarded to the Ambursen Hydraulic Construction Company the contract for constructing a reenforced concrete dam over sixty feet high, the power-house, canal, transformer house and other construction work for its power development on Union river, at Ellsworth, Me. J. A. Leonard, Ellsworth, Me., is engineer, and Sellers & Rippey, Philadelphia, Pa., are consulting engineers.

GOSHEN, N. Y.—The Goshen Light and Power Company has been reorganized, control of its stock and property having been acquired by the Orange & Rockland Electric Company. The board of directors as now constituted is composed of Henry B. Knight, Joseph Merritt, A. V. D. Wallace and W. A. Wells, of Goshen; George R. Conklin and R. W. Smith, of Monroe, and W. A. Lawrence, of Chester. R. W. Smith was elected president, and H. B. Knight, secretary.

FLORENCE, COL.—The Arkansas Valley Electric Company has sold its abandoned electric plant to a Denver company, who will dismantle the building and ship it to Denver. The local electric company is securing its current from the Colorado Power Company at Canon City. The Arkansas valley people have been awarded the contract to furnish electric lights for the town of Rockvale, and wiring the camp will be commenced soon. A five-year franchise has been secured.

WAUPACA, WIS.—The Waupaca Electric Light and Railway Company stockholders at their annual meeting reelected the former board of directors, as follows: Charles Churchill, Irving P. Lord, Wallace H. Lord, A. M. Penney, P. M. Olfson. The directors met afterwards and elected the following officers: A. M. Penney, president; Wallace H. Lord, vice-president; P. M. Olfson, treasurer; Irving P. Lord, secretary and general manager, all being reelections except the vice-president, which office was created at the meeting.

ASHLAND, WIS.—At a council meeting it was decided by a unanimous vote to go to work at once and prepare plans and call for bids for a municipal lighting plant. It was also definitely decided to pay for the plant by special bonds to be issued against the plant and its income, these bonds not to be general city liability bonds. In addition to taking this action the council decided to appropriate the sum of $5,000 to buy a sufficient amount of the land on White river so that the city could secure possession of it at once for the development of a water power.

MILFORD, OHIO—At a meeting of the council the matter of granting a franchise for furnishing electricity to the town and its citizens for lighting and power purposes was taken up. A proposition was submitted from J. J. Peurrung, general manager of the Cincinnati, Milford & Loveland Traction Company, also one from a Mr. Rugg, of Terrace Park. The matter was discussed with these two gentlemen on a basis of a franchise for ten years and the solicitor was instructed to prepare an ordinance granting a franchise for ten years and present the same to the council for action.

REDDING, CAL.—As further important units in the project of the Pacific Power Company, which is preparing to install the largest electric plant in the northern part of the state, the purchase of the Hamilton ranch of 500 acres and the signing of an agreement by Carl Schuler to sell his property, have been consummated. The properties above named are situated near Manton, and, together with the purchase of the Daniel Gover land, which is the location chosen for the 15,000-horse-power plant, place the company in a controlling position as regards the use of water and eliminates, it is said, any possible obstacle.

BALTIMORE, MD.—The Roland Park Electric and Water Company has filed a mortgage deed of trust in the clerk's office at Towson in favor of the Continental Trust Company to secure an issue of 400 thirty-year five per cent gold bonds of $1,000 each. Of this issue $300,000 will be put out at once for the purpose of retiring and canceling bonds heretofore issued by the Roland Park Electric and Water Company to the Baltimore Trust and Guarantee Company, of which only $312,000 worth have been used out of an authorized issue of $500,000. The above action was taken in accordance with an agreement between the Roland Park Electric and Water Company and the Roland Park and Consolidated Gas, Electric Light and Power companies. The Roland Park Company is now the holder of the first issue of bonds.

LAKEPORT, CAL.—At a special meeting the town council granted a franchise to the Lake County Electric Power Company to install an electric lighting and power system within the town limits. G. W. Scott, W. W. Van Arsdale and Theodore A. Bell are the principal stockholders of this corporation, which was organized for the purpose of distributing electricity throughout Lake county. The company will receive its electricity from the plant of the Snow Mountain Power and Water company, which is in course of construction on Eel river. Scott and Van Arsdale, ex-Senator J. N. Felton and others are interested in the Snow Mountain project. They will run a high potential line through Lake county. It is the intention of the Lake County Electric Power Company to have its lighting system installed by next October.

BOWLING GREEN, KY.—The Green River Hydroelectric Company, of which H. D. Fitch, of Bowling Green, is president, has leased from the United States government land and surplus water at Lock 5 on the Green river, where a plant will be built to develop about 1,000 kilowatts. This power will be transmitted to Bowling Green, a distance of thirteen miles. The Kentucky River Hydroelectric Company, of which T. L. Fitch, of Louisville, Ky., is president, will develop water power at several dams on the Kentucky river. It will transmit this power to manufacturing and other industrial enterprises at Lexington, Frankfort, Paris, Richmond and other points. The National Power Company, of which S. H. Ellison, Jr., of Nashville, Tenn., is secretary, proposes to utilize the water power at Lock A, on the Cumberland river, and transmit the power to Nashville, which is twenty-two miles distant.

TELEPHONE AND TELEGRAPH.

STERLING, NEB.—The Independent Telephone Company has leased the Pohlans block and proposes to install a new system. The company will reduce rates to $1 per month.

WATERTOWN, N. Y.—Several of the local independent telephone lines in Adams and Rodman will probably be brought together under the title of the Adams Center Telephone Company. The merger is proposed for mutual benefits.

LITTLE ROCK, ARK.—As soon as materials arrive the reconstruction of the telegraph line between Van Buren and Wagoner, I. T., a distance of ninety miles, will commence. There will be thirty-five poles to the mile on the new line, each of which will carry two six-wire arms.

BELLEFONTAINE, OHIO—The Bell Telephone Company is organizing farmers' telephone companies in every township in Logan county. When the farmers have erected the lines the Bell people will do the switching, furnish free county service and provide receivers and transmitters at a rental of $4 a year.

BESSEMER, ALA.—The Southern Bell Telephone Company is making extensive improvements in and about Bessemer. The work, when finished, will cost about $10,000 or $12,000. New cables are being installed all over the city and in Jonesboro and Lipscomb, which will, it is claimed, greatly facilitate the service.

HARTFORD, CT.—A resolution has been introduced in the legislature incorporating the Farmington Valley Telephone Company, and authorizing it to own, equip, sell, operate and maintain systems of telephone exchange and telegraph in any or all of the cities, towns and boroughs of Connecticut and other states. It may increase its present capital of $54,000 to $500,000.

BOSTON, MASS.—At the annual meeting of the Southern Massachusetts Telephone Company, the following officers were elected: president, Thomas Sherwin, of Boston; vice-president, Jasper N. Keller, of Boston; directors: Frederick P. Fish, of Boston; Thomas Sherwin, Jasper N. Keller, Charles F. Ayer, of Lowell; Francis A. Couston, of Boston; Dr. Otis Parker, of Lowell; Charles W. Clifford, of New Bedford.

DAVENPORT, IOWA—The city council has passed the ordinance granting to the Central Union Telephone Company a new twenty-five-year franchise. This ordinance provides that the company shall place its lines underground in the fire limits, shall give the city a new and up-to-date fire and police alarm system, and fixes local telephone rates on an equal basis with those of cities of like size in the state. The company will also pay all costs of litigation.

HAMILTON, ONTARIO—Cayuga town council has granted a fifteen-year franchise to the Erie Telephone Company. The company agrees to commence the construction of the system in the village within six months. The Erie company purposes to extend also to Gypsum Mines, York and Canfield, thus giving telephone communication with all points in the vicinity. It is said that the new company may make some arrangement with the Bell Telephone Company in order to gain a good long-distance connection.

CHICAGO, ILL.—Three new telephone companies have been chartered in Springfield to do a long-distance telephone business, with Chicago as the centre. The charter also grants the right to manufacture apparatus. The new companies are the Chicago, St. Louis & Western; Chicago, Milwaukee & Northern, and the Chicago, Indiana & Eastern Long Distance Telephone Companies. The capital in each case is $5,000, and the incorporators are Conrad H. Poppenhausen, Joseph L. McNab and William G. Hamilton. Mr. Poppenhausen states that the new companies have been formed to extend the automatic long-distance telephone service to outside points.

NASHVILLE, TENN.—At the regular annual meeting of the board of directors of the Cumberland Telephone and Telegraph Company the present officers of the company were reelected for the ensuing year, as follows: James E. Caldwell, president; W. W. Berry, William Litterer and A. G. Sharp, vice-presidents; Leland Hume, general manager; T. D. Webb, treasurer, and H. Blair Smith, auditor. At a meeting of the company held in Hopkinsville, W. S. Bransford, of Nashville, and John W. Barr, Jr., of Louisville, were elected to membership on the board of directors to succeed Nat. Baxter, Jr., resigned, and George R. Knox, deceased, these two vacancies having occurred since the last meeting.

ELECTRIC RAILWAYS.

POTTSTOWN, PA.—Plans and specifications have been prepared for the extension of the Ringing Rocks trolley line, recently acquired by the Schuylkill Valley Traction Company, to Boyertown.

ROANOKE, VA.—The Roanoke Railway and Electric Company has announced that it will begin at once the erection of a new modern plant, to cost $225,000, on a site purchased recently from the Norfolk & Western Railway Company.

MARQUETTE, MICH.—A deal has just been consummated by which the Marquette County Gas Light and Traction Company secures the property of the Marquette car systems at Ishpeming and Negaunee. The properties brought $289,000.

BRADFORD, PA.—The Western New York & Pennsylvania Traction Company, which recently acquired the Bradford and Olean lines, is to construct another line between this city and Carrollton, N. Y. At Carrollton, the proposed new line will connect with the trolley system between Olean and Salamanca.

BIRMINGHAM, ALA.—The Birmingham Railway, Light and Power Company will materially add to the power-house on Powell avenue, this year. The plans have been drawn and the appropriation made for these additions, which it is estimated will more than take care of the increased demands for 1907.

WEST POINT, VA.—The West Point Traction Company has been organized, and the following officers elected: J. W. Marshall, president; G. E. Guvernator, vice-president; J. W. Owens, secretary and general manager; G. C. Guvernator, A. J. Bagby and W. C. Dunham, board of directors. This company will operate motor cars for the transportation of passengers and freight in this section.

HUNTSVILLE, ALA.—The power plant of the Huntsville Railway Light and Power Company, will be doubled within the next few months. The purpose is to provide against an accidental shutdown of the service. It is also generally believed that it means the extension of the car system. The duplicate plant will cost something between $30,000 and $40,000 and will necessitate the enlargement of the power plant building.

ALBANY, N. Y.—The state railroad commission has consented to the issuance of a first mortage for $200,000 by the Putnam & Westchester Traction Company; a first mortgage for $4,500,000 by the Schenectady & Margaretville Railroad; a first mortgage for $1,000,000 by the Hancock & East Branch Railroad; and a first mortgage for $1,000,000 by the Hudson River & Eastern Traction Company. All these companies recently received the permission of the commission to build the proposed roads.

NEW ORLEANS, LA.—Representatives of the Stone & Webster syndicate, of Boston, have closed the deal for the purchase of the property of the Baton Rouge Electric and Gas Company. The purchase price was $150,000. C. D. Wyman, formerly manager of the New Orleans Traction Company, but now a member of the Stone & Webster syndicate, will immediately succeed John D. Fisher as president of the company. Plans for rebuilding and renovating the entire plant of the Baton Rouge Electric and Gas Company will now be perfected and executed.

BETHLEHEM, PA.—Capitalists of Bethlehem, Nazareth and Stroudsburg are at work on a direct trolley line between Philadelphia and Delaware Water Gap. The nearest trolley road is now fourteen miles from this mountain resort. The new road will extend from Wind Gap to Saylorsburg, thence to the trolley road now being build by Wilkes-Barre capitalists to East Stroudsburg and the Gap. It is to be known as the Stroudsburg & Wind Gap Street Railway Company, of which J. B. Williams, of Stroudsburg, is president. A power plant will be located at Pen Argyl.

OAKLAND, CAL.—The Southern Pacific Company has completed the purchase of an entire block west of Fruitvale avenue, the consideration being $30,000. The property was purchased by the company as a site for the new power-house and car barns which it will erect in connection with the establishment of an electric line to supersede the steam roads which now accommodate the local travel in Oakland and Alameda. The company proposes to erect one large power plant at this point for the generation of the electric current for the entire new system. This will require an outlay of half a million dollars.

INDUSTRIAL ITEMS.

THE AUTOMATIC OIL CUP COMPANY, Milwaukee, Wis., is distributing an illustrated catalogue devoted to the "Bangs" automatic oil cups.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, will be pleased to send to anyone interested upon request its new bulletin devoted to coal and ash-handling machinery for power-plants.

THE BENJAMIN ELECTRIC MANUFACTURING COMPANY, Chicago, Ill., has issued a Spanish catalogue covering its line of lighting fixture specialties. This catalogue will be sent to any one interested upon request.

THE ROBERT INSTRUMENT COMPANY, 56 Shelby street, Detroit, Mich., has ready for distribution a folder describing and illustrating Robert pocket volt-ammeters, pocket voltmeters and switchboard ammeters and voltmeters.

THE FRANKLIN ELECTRIC MANUFACTURING COMPANY, Hartford, Ct., has leased the Davis Merriam property on Hubbard street, Middletown, Ct. This property will be developed as an addition to its present large facilities in Hartford, Ct.

THE MASSACHUSETTS CHEMICAL COMPANY, Walpole, Mass., announces that it has been obliged to build a large addition to its factory, which has been equipped with the best of modern rubber machinery, practically doubling the capacity of the plant.

THE ALLIS-CHALMERS COMPANY, Milwaukee, has recently published two interesting and instructive bulletins. The first, No. 1,038, is devoted principally to a pictorial exposition of typical installations of alternating-current generators. The second, No. 115, gives directions for erecting Gates elevators.

THE NEW YORK ELECTRIC CONTROLLER COMPANY, New York city, will move to 35-37 Rose street, in the early part of April, where it will secure facilities and modern equipment for turning out its motor-starters and controllers. This move has been made necessary because of the increased demand for apparatus and the necessity for larger facilities.

THE ELECTRIC CABLE COMPANY, 17 Battery Place, New York city, has recently received large duplicate orders for "Voltax," the high-potential insulating compound, from the New York Central & Hudson River Railroad Company, for use at High Bridge, N. Y., where extensive electrical work is being done. Duplicate orders have been received also from the Philadelphia Electric Company and the Public Service Corporation of New Jersey.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., has ready for distribution the following literature: bulletin No. 1,087, describing and illustrating standard direct-current switchboard panels; No. 1,089 standard alternating-current panels for single-phase circuits; No. 1,090, series alternating-current arc-lighting system. There is also a new bulletin index and instruction book No. 3,024, devoted to series alternating-current arc systems.

DOSSERT & COMPANY, 242 West Forty-first street, New York city, announces that the Western Electric Company has adopted the Dossert solderless joint throughout in the electrical equipment of its new plant at Hawthorne, Ill. It is stated that a test for conductivity showed the mechanical joint to have a loss of 0.05 per cent, compared with a loss of 0.30 per cent for the soldered joint. The mechanical joint also saved more than two feet of cable, the cost of which was said to be equal to that of the joint itself.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., in bulletin No. 74, describes and illustrates engine-type alternating-current generators. The descriptive matter is interesting and instructive, and the view shows some of the details of construction and a few of the Crocker-Wheeler generators in successful operation. A very interesting illustration is that of a 4,000-kilowatt-ampere gas-engine-driven alternating-current generator installed at the plant of the California Gas and Electric Corporation, San Francisco, Cal.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has ready for distribution the following price lists: No. 5,159, devoted to Edison incandescent lamps of the carbon-filament type; No. 5,160, Edison miniature incandescent lamps; No. 5,161, fan motors. The following bulletins are also being distributed: No. 4,481, signal relays; No. 4,482, a guide to the design of medium and small-capacity central-station switchboards; No. 4,484, railway signals, top-mast, direct-connected, two and three-position type; No. 4,486, the CQ motor.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has issued the 1907 edition of the Exide battery instruction book. This edition is more complete than heretofore, and describes the various parts comprising the battery, giving in detail the method of operating and caring for the apparatus, as well as instructions for assembling and putting it in commission. The book is being distributed by vehicle manufacturers, Exide battery depots and Exide distributors located in the principal cities throughout the country. Upon request any branch sales office of the company will furnish copies.

Directory of Electrical and Allied Engineering and Scientific Societies.

(Published in the Second Issue of Each Month.)

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Secretary, L. O. Howard, Cosmos Club, Washington, D. C.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Secretary, Dr. C. E. Skinner, New Haven, Ct.

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, S. S. Sadtler, 39 South Tenth street, Philadelphia.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Secretary, Ralph W. Pope, Engineering Societies Building, 29 West Thirty-ninth street, New York city. Meetings, fourth Friday of each month.

AMERICAN MATHEMATICAL SOCIETY. Secretary, F. N. Cole, 50 West 116th street, New York city.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Secretary, J. W. Taylor, Old Colony Building, Chicago, Ill.

AMERICAN ROENTGEN RAY SOCIETY. Secretary, Dr. G. C. Johnston, 514 Bijou Building, Pittsburg, Pa.

AMERICAN SOCIETY FOR TESTING MATERIALS. Secretary, Professor Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Secretary, Calvin W. Rice, 12 West Thirty-first street, New York city.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Secretary, G. W. Tillson, Municipal Building, Brooklyn, N. Y.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION. Secretary, B. V. Swenson, 60 Wall street, New York city.

AMERICAN STREET AND INTERURBAN RAILWAY ENGINEERING ASSOCIATION. Secretary, S. W. Mower, London, Canada.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, Ernest H. Davis, Williamsport, Pa.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Secretary, P. W. Drew, Milwaukee, Wis. Annual meeting, Atlantic City, N. J., June 19, 1907.

ASSOCIATION OF ELECTRIC LIGHTING ENGINEERS OF NEW ENGLAND. Secretary, Welles E. Holmes, 308 Washington street, Newton, Mass. Annual meeting held in Boston on third Wednesday in March.

CALIFORNIA INDEPENDENT TELEPHONE ASSOCIATION. Secretary, P. T. Whittier, Spencer, Cal.

CANADIAN ELECTRICAL ASSOCIATION. Secretary, T. S. Young, Toronto, Canada.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION. Secretary, J. F. Dostal, Denver, Col.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Secretary, E. W. Poole, Bridgeport, Ct.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Secretary, J. I. Lyle, 39 Cortlandt street, New York city.

ELECTRIC CLUB OF CLEVELAND. Secretary, George L. Crosby, 1200 Schofield Building, Cleveland, Ohio.

ELECTRICAL CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, John P. Faure, 77 Water street, Ossining, N. Y.

ELECTRICAL CONTRACTORS' ASSOCIATION OF STATE OF MISSOURI. Secretary, Charles J. Sutter, 1220 Pine street, St. Louis, Mo.

ELECTRICAL TRADES ASSOCIATION OF CHICAGO. Secretary, Frederick P. Vose, Marquette Building, Chicago.

ELECTRICAL TRADES ASSOCIATION OF PHILADELPHIA. Secretary, E. A. Symmes, 810 Drexel Building, Philadelphia, Pa. Meetings, second and fourth Thursdays each month.

ELECTRICAL TRADES ASSOCIATION OF CANADA. Secretary, William R. Stavely, Royal Insurance Building, Montreal, Canada.

ELECTRICAL TRADES ASSOCIATION OF THE PACIFIC COAST. Secretary, Albert H. Elliott, Claus Spreckles Building, San Francisco, Cal. Monthly meetings, San Francisco, first Thursday of each month.

ELECTRICAL TRADES SOCIETY OF NEW YORK (Member National Electrical Trades Association). Secretary, Franz Neilson, 80 Wall street, New York city. Board of directors meets second Friday of each month.

EMPIRE STATE GAS AND ELECTRICAL ASSOCIATION. Secretary, Rolland A. Davidson, 58 William street, New York city.

ILLINOIS STATE ELECTRICAL ASSOCIATION. Secretary, H. E. Chubbuck, La Salle, Ill.

ILLUMINATING ENGINEERING SOCIETY. Secretary, Van Rensselaer Lansingh, Engineering Societies Building, 33 West Thirty-ninth street, New York city.

INDEPENDENT TELEPHONE ASSOCIATION OF SOUTHERN INDIANA. Secretary, E. W. Landgrebe, Huntingburg, Ind.

INDIANA ELECTRIC RAILWAY ASSOCIATION. Secretary, P. H. White, Indianapolis, Ind. Monthly meetings, second Tuesday of each month.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, Frank P. Foster, Corning, N. Y. Next meeting, Norfolk, Va.

INTERNATIONAL INDEPENDENT TELEPHONE ASSOCIATION. Secretary, A. L. Tetu, Nashville, Tenn.; assistant secretary, J. A. Harney, Electric Building, Cleveland, Ohio.

IOWA ELECTRICAL ASSOCIATION. Secretary, L. B. Spinney, Iowa State College, Ames, Iowa.

IOWA STREET AND INTERURBAN RAILWAY ASSOCIATION. Secretary, L. D. Mathes, Dubuque, Iowa.

IOWA TELEPHONE ASSOCIATION. Secretary, C. C. Deering, Boone, Iowa.

KANSAS GAS, WATER AND ELECTRIC LIGHT ASSOCIATION. Secretary, James D. Nicholson, Newton, Kan. Next meeting, Topeka, Kan., October 16, 1907.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION. Secretary, J. W. Chambers, Winchester, Ky.

MAINE STREET RAILWAY ASSOCIATION. Secretary, E. A. Newman, 471 Congress street, Portland, Me.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Secretary, Charles S. Clark, 70 Kilby street, Boston, Mass. Meets second Wednesday of each month, except July and August.

MASTER CAR BUILDERS' ASSOCIATION. Secretary, J. W. Taylor, 390 Old Colony Building, Chicago, Ill.

MICHIGAN ELECTRIC ASSOCIATION. Secretary, A. C. Marshall, Port Huron, Mich.

MISSOURI INDEPENDENT TELEPHONE ASSOCIATION. Secretary, James F. Barnett.

NATIONAL ARM, PIN AND BRACKET ASSOCIATION. Secretary, J. B. Magers, Madison, Ind.

NATIONAL ELECTRICAL TRADES ASSOCIATION. Secretary, Fred P. Vose, 1343 Marquette Building, Chicago.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton, 94 Genesee street, Utica, N. Y. Next meeting, New York city, July 17, 1907.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Secretary, W. C. L. Eglin, Engineering Societies Building, 33 West Thirty-ninth street, New York city.

NEW ENGLAND ELECTRICAL TRADES ASSOCIATION. Secretary, Alton F. Tupper, 84 State street, Boston, Mass.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, Engineering Societies Building, 29 West Thirty-ninth street, New York city.

NEW YORK STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, R. Max Eaton, Niagara Falls, N. Y.

NORTHWESTERN ELECTRICAL ASSOCIATION. Secretary, R. U. Kimball, Kenosha, Wis. Next annual meeting, Milwaukee, Wis.

OHIO ELECTRIC LIGHT ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio. Next annual meeting, Toledo, August 20, 21 and 22.

OHIO INDEPENDENT TELEPHONE ASSOCIATION. Secretary, Ralph Reamer, Portsmouth, Ohio.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Secretary, F. W. Bullard, Cleveland, Ohio.

OHIO STREET RAILWAY ASSOCIATION. Secretary, Charles Currie, Akron, Ohio.

OLD TIME TELEGRAPHERS AND HISTORICAL ASSOCIATION. Secretary, John Brant, 195 Broadway, New York city.

ORDER OF THE REJUVENATED SONS OF JOVE. C. B. Roulet, Mercury, Dallas, Tex.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Secretary, Samuel G. Reed, Portland, Ore.

PENNSYLVANIA STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, H. E. Bradley, 135 South Second street, Philadelphia, Pa.

PENNSYLVANIA STATE STREET RAILWAY ASSOCIATION. Secretary, Charles H. Smith, Lebanon, Pa.

PIKE'S PEAK POLYTECHNIC SOCIETY. Secretary, E. A. Sawyer, Colorado Springs, Col. Meetings, second Saturday of each month.

RAILWAY SIGNAL ASSOCIATION. Secretary, C. C. Rosenberg, Bethlehem, Pa. Annual meeting, Milwaukee, Wis., October 14, 1907. Next meeting, Chicago, Ill., March 18.

RAILWAY TELEGRAPH SUPERINTENDENTS' ASSOCIATION. Secretary, P. W. Drew, Wisconsin Central Railway, Milwaukee, Wis. Annual meeting, Atlantic City, N. J., June 19-20.

SOUTHWESTERN GAS, ELECTRIC AND STREET RAILWAY ASSOCIATION. Secretary, T. H. Stuart, Waco, Tex.

UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION. Secretary Electrical Committee, C. M. Goddard, 55 Kilby street, Boston, Mass.

VERMONT AND NEW HAMPSHIRE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, G. W. Buzzell, St. Johnbury, Vt.

VERMONT ELECTRICAL ASSOCIATION. Secretary, C. C. Wells, Middlebury Electrical Light Company, Middlebury, Vt.

VIRGINIA STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, E. L. Fisher, Rocky Mount, Va.

WESTERN ASSOCIATION OF ELECTRICAL INSPECTORS. Secretary, W. S. Boyd, Chicago.

WESTERN SOCIETY OF ENGINEERS (Electrical Section). Secretary, J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

Record of Electrical Patents.

Week of February 26.

845,048. STORAGE-BATTERY PLATE. Joseph Bijur, New York, N. Y., assignor to the General Storage Battery Company. A method of mounting elements in the grid.

845,051. ELECTRIC-RESISTANCE APPARATUS. Rolf von Brockdorff, Bregenz, Austria-Hungary. The metallic skeleton constitutes the electrical resistance.

845,053. INCANDESCENT-LAMP BULB. David F. Campbell, Vancouver, British Columbia, Canada. A concave, convex bulb containing a ring-shaped filament.

845,056. TELEPHONE SYSTEM. Elmer R. Corwin, Chicago, Ill. A modified common battery system.

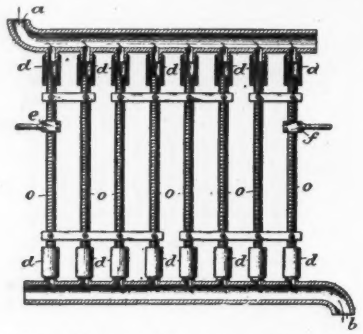
845,062. TELEPHONE TRANSMITTER. James M. Dempsey, Chicago, Ill., assignor of three-tenths to William B. Beckman, Fayetteville, Ark., and three-tenths to Harry T. Rogers and one-tenth to Madeline Dempsey, Chicago, Ill. The resistance material is enclosed in a cell.

845,077. TELEPHONE TRUNKING SYSTEM. Harry C. Goldrick, Indianapolis, Ind., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. Supervisory signals are employed at the outgoing end.

845,101. POLARITY INDICATOR. Paul Leo, Elizabeth, N. J. A polarized indicator connected in the line.

845,111. CIRCUIT FOR COIN-COLLECTORS. James L. McQuarrie, Chicago, Ill., assignor to Western Electric Company, Chicago, Ill. A method for controlling the coin-collector.

845,112. CIRCUIT FOR COIN-COLLECTORS. James L. McQuarrie, Chicago, Ill., and Henry M. Crane, New York, N. Y., assignors to Western Electric Company, Chicago, Ill. Employs a coin-distributing magnet.



845,051.—ELECTRIC-RESISTANCE APPARATUS.

845,126. MAGNETIC CLUTCH. Alfred W. Saville, Chicago, Ill., assignor to Western Electric Company, Chicago, Ill. A double-ended magnetic clutch.

845,157. COMPOSITE TELEPHONIC AND TELEGRAPHIC CIRCUIT. George M. Yorke, New York, N. Y., assignor to American Telephone and Telegraph Company. A telephone system is bridged on the line.

845,188. RAILWAY SIGNAL SYSTEM. Francis M. Myers, Windsor, Mo., assignor of one-third to Charles A. Draper, Windsor, Mo., and one-third to Philip H. Kilpatrick, Corinth, Miss. An automatic block system.

845,219. ELECTROTHERMAL CUT-OUT. Frank B. Cook, Chicago, Ill. A protector of homogeneous resistance material.

845,220. BLOCK SIGNAL SYSTEM. Fred B. Corey, Schenectady, N. Y., assignor to General Electric Company. An alternating-current signaling system.

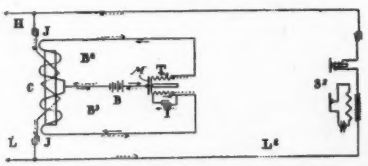
845,268. SPRING TERMINAL-CLIP. John Schade, Jr., Brooklyn, N. Y., assignor to Fahnestock Electric Company. A spring clip for conductors.

845,281. ELECTRICALLY OPERATED VALVE. Leonard A. Tirrill, Lynn, Mass., assignor to General Electric Company. A system of remote control.

845,282. TELEPHONIC-CURRENT REINFORCER OR REPEATER SYSTEM. Nathaniel G. Warth, Columbus, Ohio. A differential repeater.

845,288. SWIVEL-TIP FOR ELECTRIC CONDUCTORS. William F. Barker, Somerville, Mass. A binding-post tip.

845,316. MEANS FOR RECEIVING INTELLIGENCE COMMUNICATED BY ELECTRIC WAVES. Greenleaf W. Pickard, Amesburg, Mass. An electrolytic receiver.



845,282.—TELEPHONIC-CURRENT REINFORCER OR REPEATER SYSTEM.

845,323. TROLLEY POLE. Charles F. Wensinger, Fremont, Ohio. A double-armed trolley.

845,328. PARTY-LINE LOCK-OUT. Mark P. Boone, Peru, Ind., assignor to the Peru Common Battery Lock-Out Telephone Company, Peru, Ind. Separable terminals are provided for the talking circuit.

845,368. INTERRUPTER FOR MAGNETOS. Theodor M. Mueller, Braintree, Mass., assignor to Willard E. Dow, Braintree, Mass. A spring contact operated by a cam.

845,370. COIN-COLLECTOR. Frank R. McBerry, Evanston, Ill., and James L. McQuarrie, Chicago, Ill., assignors to Western Electric Company, Chicago, Ill. A temporary coin-receiver is provided.

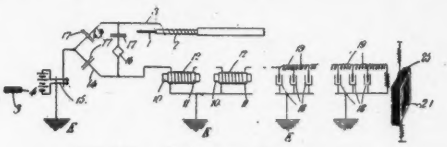
845,405. TRACTOR FOR ELECTRICAL TOWAGE SYSTEMS. Léon Gerard, Brussels, Belgium, assignor, by mesne assignments, to American Adhesion Traction Company. Gripping-wheels are provided on the tractor.

845,406. ELECTRICALLY DRIVEN FLUID-PRESSOR. Arthur H. Gibson, Easton, Pa., assignor to the Ingersoll-Sergeant Drill Company, New York, N. Y. A method of driving a reciprocating compressor.

845,413. ELECTRIC-RESISTANCE THERMOMETER. Ernst Haagn, Hanau, Germany, assignor to the firm of W. C. Heraeus, Hanau, Germany. The resistance element is surrounded by quartz-glass.

845,452. TELEPHONE TRUNKING SYSTEM. Francis W. Dunbar, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A method of connecting in a trunk.

845,459. ELEVATED ELECTRIC RAILWAY. James M. Gilstrap, Oakland, Cal. A method of construction.



845,609.—ELECTRIC CONDUCTOR.

845,476. SWITCH MECHANISM FOR ELECTRIC-LAMP SOCKETS AND THE LIKE. James P. Neilson, Bridgeport, Ct., assignor to the Bryant Electric Company, Bridgeport, Ct. A key-switch.

845,496. INSULATED RAIL-JOINT. George W. Whiteman, Philadelphia, Pa. A method of insulating splice-bars.

845,522. AUTOMATIC SIGNAL ATTACHMENT FOR TELEGRAPH REGISTERS. John C. Carmody and Walter K. Pulsifer, Fitchburg, Mass. The recorder automatically lights a lamp.

845,533. TELEPHONE SYSTEM. William W. Dean, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A plurality of testing contacts is provided.

845,546. TELEPHONE MAGNET. Aaron E. Harrison, New York, N. Y., and Crowell M. Haslett, Jersey City, N. J. A ring magnet with laterally projecting poles.

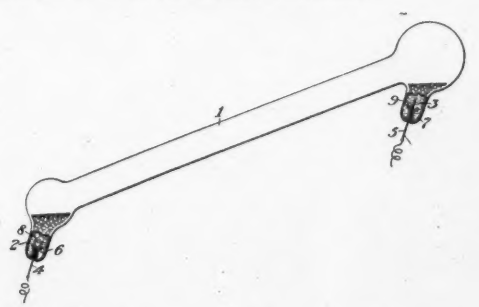
845,585. CARBON ELECTRODE AND THE METHOD OF PRODUCING THE SAME. Truman P. Sharts, Readsboro, Vt., assignor of one-fourth to Charles J. Howe, Jamaica, Vt., and one-fourth to William C. Davis and one-fourth to J. H. Cole, Readsboro, Vt. Carbon is produced by the combustion of petroleum.

845,609. ELECTRIC CONDUCTOR. Sidney G. Brown, London, England. A spirally wound conductor, the adjacent turns being insulated.

845,614. POT-HEAD. William Callahan, South Bend, Ind. Three compartments are provided through which the conductor passes.

845,637. WATCHMAN'S ELECTRIC TIME-DETECTOR. Otto E. Hausburg, New York, N. Y. The recording perforators are crank-shaped.

845,655. AUTOMATIC CIRCUIT-BREAKER. Harry W. Leonard, New York, N. Y. A no-voltage circuit-breaker.



845,722.—PROTECTING DEVICE FOR VAPOR APPARATUS.

845,656. ELECTRIC-CIRCUIT CONTROLLER. Harry W. Leonard, Bronxville, N. Y. A motor starter.

845,670. VACUUM APPARATUS. Percy H. Thomas, East Orange, N. J., assignor to Cooper Hewitt Electric Company, New York, N. Y. Undesirable gases are removed from the apparatus by passing other vapors through it.

845,683. SIGNALING SYSTEM FOR ELECTRIC RAILWAYS. Charles P. Breese, Norfolk, Va., and Adoniram J. Wilson, Westfield, N. J., assignors to the Hall Signal Company. A block-signal system.

845,722. PROTECTING DEVICE FOR VAPOR APPARATUS. Percy H. Thomas, East Orange, N. J., assignor to Cooper Hewitt Electric Company, New York, N. Y. Cup-shaped receptacles surrounding the lead-in wires protect the latter from sudden jars.